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STRATEGIC ROLE OF NATIONAL METROLOGY INFRASTRUCTURE IN ECONOMIC DEVELOPMENT OF UZBEKISTAN

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Annotation. *This article explores the strategic importance of Uzbekistan's National Metrology Infrastructure in supporting economic development, improving industrial competitiveness, and integrating the nation more effectively into global value chains. It presents an overview of the current metrology landscape, examines the economic impact of measurement systems in key sectors, identifies challenges, and offers policy recommendations to strengthen this critical component of national infrastructure.*

Keywords: *National Metrology Infrastructure, Global Quality Infrastructure, Economy, Industries*

1. INTRODUCTION

In the modern global economy, precision, reliability, and quality are not luxuries -they are necessities. At the heart of these requirements lies metrology, the science of measurement, which serves as the foundation for industrial innovation, regulatory compliance, scientific research, and international trade. A well-functioning National Metrology Infrastructure (NMI) ensures that measurements in production, health, energy, environment, and commerce are accurate and traceable to international standards [1]. For a developing economy like Uzbekistan, strengthening its metrological system is not just a technical task - it is a strategic priority for long-term, sustainable economic growth [3-4].

Uzbekistan, a country with a GDP of $90.7 billion USD in 2023 and an annual growth rate of approximately 5.5%, is undergoing significant economic reforms aimed at modernization, diversification, and global integration [5]. Key sectors such as textiles, agriculture, energy, pharmaceuticals, and mining depend heavily on accurate measurements to meet both national quality requirements and international export standards. According to the Uzbek State Committee on Statistics, exports in 2023 reached $21.5 billion, with agriculture and manufactured goods contributing more than 60% - sectors where metrological control is critical for product certification, safety, and market access [6-7].

2. Current National Metrology Infrastructure of Uzbekistan

Based on the Law of the Republic of Uzbekistan "On Metrology", metrological control of measuring devices are carried out by state body, executive authorities and economic management

bodies and private metrological organizations (figure 1). The law also indicates that Uzbek National Institute of Metrology is a specially authorized state body [2].

According to the statistics of Uzbek Accreditation Center, currently there are 22 verification and 22 calibration labs under state body, 60 verification and 1 calibration labs under executive authorities and economic management bodies, and 34 private verification 4 private calibration labs in Uzbekistan [9]. Totally 116 verification labs and 27 calibration labs are conducting metrological services in the republic.

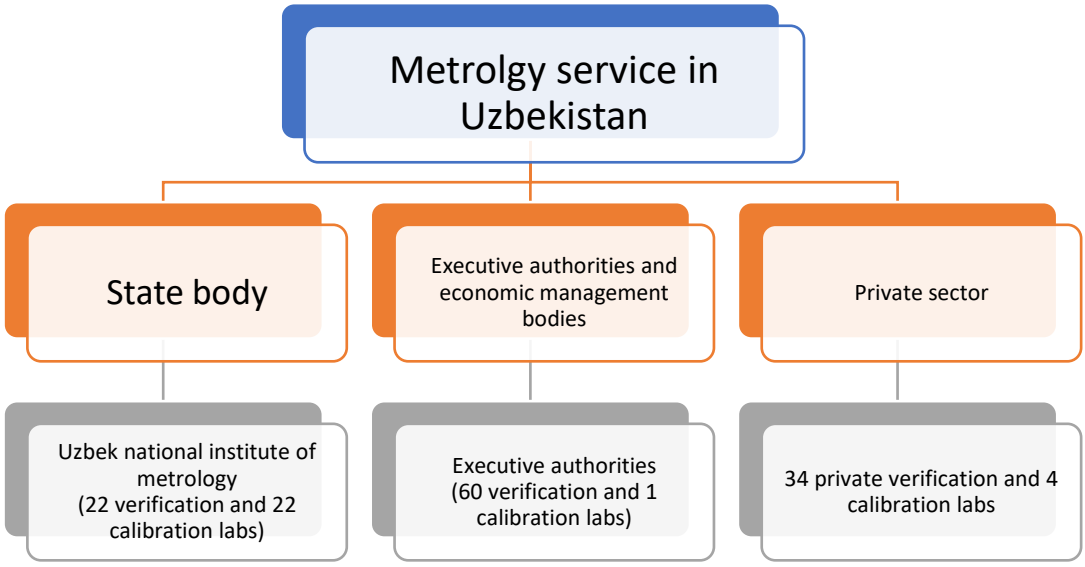

Figure 1. Metrology service in Uzbekistan

Uzbekistan became an associate member of the General Conference on Weights and Measures on July 13, 2018. This membership plays a pivotal role in shaping a nation's metrology infrastructure and, by extension, its economic development such as:

1. Establishing International Measurement Standards

The CGPM is responsible for adopting and refining the International System of Units (SI), ensuring uniformity in measurement standards across member states.

2. Facilitating Mutual Recognition of Measurement Capabilities

Through the CIPM Mutual Recognition Arrangement (CIPM MRA), initiated in 1999, the CGPM enables national metrology institutes to mutually recognize the equivalence of their measurement standards and calibration certificates.

3. Promoting Capacity Building and Knowledge Transfer

The CGPM has initiated joint programs to transfer knowledge and build capacity in countries with emerging metrology systems.

4. Supporting Sustainable Development Goals

The CGPM's efforts in standardizing measurements contribute to goals related to economic growth, innovation, and fair trade. The United Nations Industrial Development Organization (UNIDO) has identified effective participation in metrology programs as essential for sustainable development.

5. Enhancing Scientific and Industrial Competitiveness

Active participation in the CGPM allows countries to align their metrology practices with international standards, fostering scientific collaboration and industrial competitiveness. This

alignment is particularly beneficial for countries seeking to integrate into the global economy and attract international investment.

3. Uzbek National Institute of Metrology

According to the decree of the President of the Republic of Uzbekistan "On measures to improve the activities of the Uzbek Agency for Standardization, Metrology and Certification" No.PP-2935 dated April 28, 2017 on the basis of the existing State Institution "Center for National Standards", State Enterprise "Center for the provision of metrological services" and metrological subdivisions of the State Institution "Research Institute of Standardization, Metrology and Certification", the Uzbek National Institute of Metrology (UzNIM) was established [11].

Currently, the UzNIM operates in accordance with international standards, possessing an infrastructure, technical resources, and qualified personnel capable of competing with leading foreign national metrology institutes.

In particular, UzNIM maintains:

- 29 national measurement standards (etalon units),
- 4,427 high-precision measuring instruments,
- Approximately 44 calibration and verification laboratories,
- A workforce of 637 qualified specialists.

Through its network of 16 regional branches across the country, UzNIM has established a system for the metrological verification of measuring devices. As a result, the institute ensures metrological coverage of approximately 55% of industrial measurements conducted within the Republic [10] and it's aimed that to establish again 29 national measurement standards (total 58) as well as to improve metrological coverage up to 78% (figure 2 and 3).

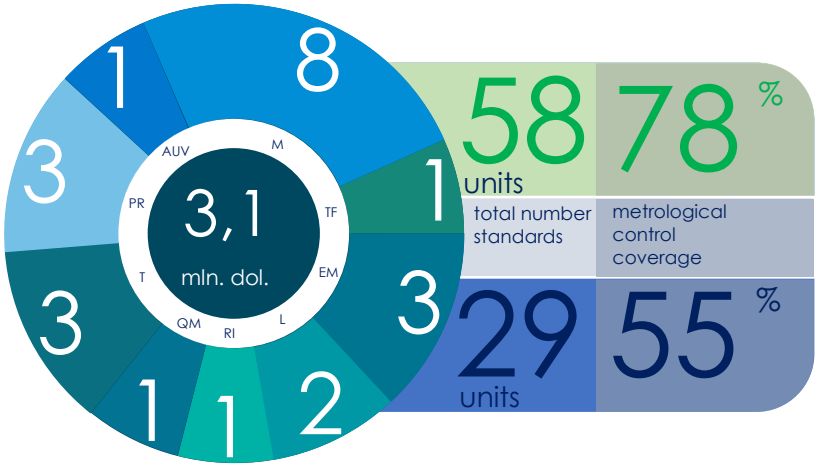

Figure 2. Metrological coverage factor

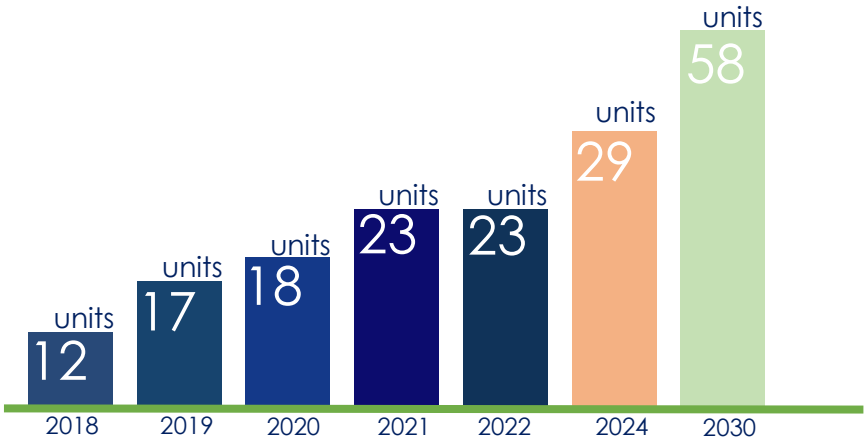

Figure 3. Quantity of National measurement standards

In the field of international cooperation, the UzNIM actively engages in a number of collaborative partnerships with key global metrological organizations.

Specifically, UzNIM has established the following memberships [10]:

- Since 2018, Corresponding Member of the International Bureau of Weights and Measures (BIPM);
- Since 2001, Corresponding Member of the International Organization of Legal Metrology (OIML);
- Since 2004, Full Member of the Euro-Asian Cooperation of National Metrological Institutions (COOMET);
- Since 2019, Corresponding Member of the Asia-Pacific Metrology Programme (APMP);
- Since 2021, Observer member and Engaged in cooperative activities of the European Association of National Metrology Institutes (EURAMET) and Gulf Association for Metrology (GULFMET);
- Active collaboration with the Standards and Metrology Institute for Islamic Countries (SMIIC);
- Participation in the Interstate Council for Standardization, Metrology and Certification (ISC) under the Commonwealth of Independent States (CIS).

In addition, UzNIM maintains close cooperation with several national metrology institutes of developed countries. These partnerships focus on strengthening metrological infrastructure, gaining international recognition for calibration and measurement capabilities, and enhancing the professional qualifications of its personnel.

4. Economic Impact of Metrology in Key Sectors



Figure 4. Current and planned metrological coverage across various industrial sectors in Uzbekistan

The image presents a comparative analysis of the current and planned metrological coverage (CVGE – possibly referring to "coverage in metrology") across various industrial sectors in Uzbekistan. Each sector is evaluated based on the percentage of metrological coverage, along with the number of standards currently applied. The current state is depicted with blue rectangles, while the planned targets are shown in green.

In the **metallurgy and construction** sector, the current metrological coverage stands at 53%, with a target to increase it to 74%, using 3 standards. Similarly, **mechanical engineering and the automotive industry** currently have a 54% coverage with 4 standards, with a goal to raise it to 71%. The **food and agricultural** sector shows one of the highest planned improvements, from a current 65% to a target of 84%, applying 6 standards, indicating a strong push for quality and accuracy in this essential area.

The **chemistry and pharmaceuticals** sector currently has a 58% coverage, with 13 standards in place, aiming for a 74% target [12-15]. This reflects the sector's complexity and the importance of precise measurement systems. In the **oil and gas, and geology** sector, coverage is currently at 52%, planned to increase significantly to 79%, supported by 8 standards. This notable rise highlights the strategic focus on resource-intensive industries.

Lastly, the **energy and electrical engineering** sector has the lowest current metrological coverage at 51%, despite utilizing the highest number of standards (24). The planned coverage is 76%, suggesting that while many standards exist, their implementation or impact is currently limited, requiring targeted improvements.

Overall, Uzbekistan's metrological development plan demonstrates a clear intent to enhance measurement infrastructure across all sectors, with particular attention given to vital industries like energy, oil and gas, and agriculture. The differences between current and planned coverage highlight both the potential for growth and the need for more efficient application of standards.

In the Global Quality Infrastructure Index (GQII), as a result of reforms in the field of accreditation, standardization and metrology, starting in 2021, Uzbekistan entered the list with 82nd place.

At the end of 2023, out of 185 countries, Uzbekistan rose to 67th place (growth rate compared to 2021 +16)

5. Challenges and Opportunities

While Uzbekistan has made remarkable progress in developing its National Metrology Infrastructure (NMI), several challenges persist that could hinder its full economic potential [8]:

Key Challenges:

Limited Metrological Reach in Rural and Industrial Areas: Despite the network of laboratories under UzNIM, some sectors and regions remain underserved, particularly in remote and high-growth industrial zones.

Dependence on Foreign Calibration and Tools: Many industries still rely on imported measurement equipment and foreign calibration services, increasing costs and reducing technological independence.

Fragmentation of Metrology Functions: Coordination among public agencies, private laboratories, and industrial stakeholders is often inconsistent, leading to inefficiencies in service delivery and data traceability.

Emerging Opportunities:

Public Good Characteristics of Metrology: As Swann (2009) emphasized, metrology exhibits classic features of a public good: high fixed costs, low marginal dissemination costs, and wide-ranging benefits. This creates a compelling case for increased state support and investment.

Support from International Institutions: Organizations like UNIDO, BIPM, and ISO provide capacity-building programs and funding opportunities that can accelerate metrological development.

Catalyst for Innovation: Improved measurement systems reduce transaction costs, support process optimization, and foster innovation — especially in high-tech industries such as pharmaceuticals, renewable energy, and advanced manufacturing.

6. Policy Recommendations and Strategic Path Forward

In line with Swann's policy framework, the following strategies are essential for reinforcing UzNIM and maximizing its economic contribution:

1. Increase Public Investment in Metrological R&D

Given the high fixed cost and the presence of positive externalities, metrological research — especially in areas like environmental monitoring, food safety, and healthcare — warrants significant public funding. This ensures that benefits are widely shared and not monopolized.

2. Enhance Regional Access and Infrastructure

Target investments toward expanding verification and calibration services in underserved regions. Mobile calibration units, digital platforms, and regional hubs could close this accessibility gap.

3. Foster Public-Private Partnerships

Encourage joint investment by the state and industry in developing new measurement technologies and upgrading laboratories, especially in strategic sectors such as energy, agriculture, and textiles.

4. Align with International Standards

Continue harmonizing national standards with those of international bodies (e.g., BIPM, OIML, ISO) to increase the export competitiveness of Uzbek products and attract foreign direct investment.

5. Promote Metrological Literacy and Workforce Development

Swann (2009) emphasizes that measurement systems also improve through better-trained human capital. Uzbekistan should expand metrology training programs and university partnerships to build a new generation of specialists.

7. Conclusion

The development of a robust and internationally aligned National Metrology Infrastructure is not merely a technical or scientific priority for Uzbekistan — it is an economic imperative. Measurement accuracy affects productivity, innovation, trade, consumer safety, and environmental protection. As shown in Swann's extensive review, metrology's role as an "infratechnology" positions it as foundational to sustainable economic progress.

Uzbekistan's recent improvements in the Global Quality Infrastructure Index (GQII) illustrate that reforms are paying off. However, to fully realize metrology's strategic potential, sustained investment, institutional collaboration, and integration with global networks are required.

Policy makers, industries, and researchers must now recognize metrology not just as a technical support function but as a national economic asset — one that can drive competitiveness, trust in trade, and long-term development.

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