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METROLOGY IN ENSURING THE QUALITY OF PRODUCTS AND SERVICES IN DIGITAL ECONOMY

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Abstract

International and domestic experience shows that the level of metrological support for production of products and services is directly related to their quality. The reliability of determining the quality indicators of products and services that are subject to confirmation during its control primarily depends on the metrological support of measurements and control. Therefore, metrology is an important link in the system of ensuring the quality of products and services at all stages of the life cycle. In addition, metrology is a necessary tool for conducting research and implementing technological innovations. Rapid scientific and technological progress requires increasingly accurate and reliable measurements in the context of the digital economy. Therefore, metrology in its development should be ahead of other areas of science and technology. At the same time, the development of metrology is impossible without improving the regulatory framework. It is generally considered that the economic value of metrology is difficult to quantify, since it underlies many sectors of the economy. Metrology contributes to scientific and technological development, innovation, and international trade. Increasing investment in metrological research and related infrastructure contributes to increasing the competitiveness of the country's digital economy.

Keywords: Metrology, quality, unity of measurements, digital economy.

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1. Introduction

In today's business environment, the quality of products and services is becoming a necessary tool for competition. Therefore, one of the main criteria for the effectiveness of any enterprise is to improve the quality of products. Maintaining and improving the quality of products and services is based on two main methods: quality control and quality assurance. These two practices are actively used by modern manufacturers to ensure that the final product or service meets certain requirements and quality standards.

There is an important difference between quality control and quality assurance. Quality control is a production-oriented activity that includes monitoring methods and actions to meet quality requirements. Quality assurance is a process-oriented, planned and systematic activity carried out in a quality system in such a way that the quality requirements for a product or service are met.

Organizations compete with each other on the basis of either producing the highest quality products or providing the best services (Alekseev et al., 2017). Quality management is one of the key functions, the main means of ensuring and maintaining a given level of quality of products or services. One of the components of the quality management system is metrological support of production and service provision, based on the practical use of the provisions of metrology and current regulatory documents.

Recommendations for interstate standardization of RMG 29-2013 GSI "Metrology. Basic terms and definitions" define metrology as the science of measurement, as well as methods and means of ensuring their unity, including ways to achieve the required accuracy. The higher the level of development of metrology, the more advanced measurement methods are used and, consequently, the higher the quality of measurements. In turn, metrologically confirmed accuracy and reliability of measurements ensure high quality of products and services.

2. Problem Statement

The rapid development of digital technologies has a significant impact on all industries and serves to provide new opportunities, reduce costs and maximize efficiency (Nesterenko & Kozlova, 2018). As a result of digital transformation, new markets are emerging, business practices are fundamentally changing, and new digital products are emerging. Metrology is no exception and in order to "fit" into the digital economy, it must have a digital infrastructure. Therefore, the main problems that should be resolved by the metrology at the present stage is:

- the transition to new technologies;
- metrological support of the digital economy communication system;
- metrological support for measuring the production of goods and services in the digital economy.

2.1. Transition to new technologies

There are several main trends in digital transformation (Bolshakov, 2017; Lotkov, 2016; Nesterenko & Kozlova, 2018). The Internet of things, blockchain technology, technologies to protect the network from cyber threats, augmented and virtual reality, big data, artificial intelligence and its Foundation, machine

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learning, are part of the global digital transformation. These trends can also be traced in the development of metrology.

Thus, the Internet of things technology is being actively implemented to collect data from a geographically distributed network of sensors by using wireless technologies and equipping sensors with additional computing power. An example is the collection of readings from utility consumption meters, which has been successfully automated recently. Readings are automatically transmitted to the utility provider in accordance with the specified frequency, which increases the reliability of data and the timeliness of their provision. At the same time, network security technologies ensure that real data on consumption volumes is hidden, which eliminates the possibility of using unauthorized data for criminal or mercenary purposes.

As for big data technology, it can be effectively used for in-depth analysis of measurement results from a large number of devices, in order to obtain, for example, additional information on measured values, to improve the methods of instrument verification.

We should also not forget about traditional automation technologies, which are reaching a new level in the context of digital transformation. So recently, single-board computers have become widely used, the use of which together with sensors allows you to create compact and multifunctional measuring tools and test equipment (Ermakov et al., 2019), easily integrated into measurement systems.

It should be noted that the active introduction of new technologies is to a certain extent hindered by the current concepts of metrology based on analog and discrete measurements (Gurtovtsev, 2008a, 2008b). The existing regulatory metrological base is focused on traditional measurement methods and methods of processing their results. It does not pay attention to the implementation features of modern digital measuring equipment, which includes a number of components that do not perform measuring functions, but provide additional features, such as the accumulation and transmission of measurement results. This approach not only makes it more difficult to check the equipment itself, but also increases its cost.

2.2. Metrological support of the digital economy communication system and measuring instruments for production of goods and services

The reliability of communication infrastructure is a key factor in the effective functioning of the digital economy. Therefore, constant metrological control of network parameters is a necessary requirement. The existing methodology and legal framework do not allow for verification and calibration of measuring systems as part of communication equipment remotely, this is only possible in metrological centers, or when directly connecting measuring instruments to communication equipment (Filippov, 2018). This circumstance not only leads to an increase in the cost of metrological support for the provision of services, but also hinders the creation of devices and the development of new measurement methods that could provide the specified accuracy regardless of the method of obtaining results.

A similar situation occurs in enterprises of the digital economy, where measuring tools are integrated into the production process, which imposes certain restrictions on the metrological support system (Filippov & Muzalevsky, 2020).

We hope that in the foreseeable future, such restrictions will be lifted and appropriate equipment will be available on the market.

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3. Research Questions

The research focuses on the development of metrology for the digital economy in the legislative, organizational, methodological and technical fields and its role in ensuring the quality of products and services. The transformation of metrology is impossible without revision and improvement of the legal framework, international cooperation, training of highly qualified specialists, methodological support and technical re-equipment.

4. Purpose of the Study

The purpose of the research is to study the problems of metrology development in the context of the digital economy and its significance in ensuring the quality of products and services. It is assumed that the answers to the research questions will help achieve this goal and serve as a basis for developing recommendations for improving the quality management of products and services in the digital economy.

5. Research Methods

5.1. Analysis of the legal framework in the field of metrology

The role of measurement in modern society cannot be overestimated. In 2016 and 2017, a Strategy was developed to ensure the uniformity of measurements in the Russian Federation until 2025 (approved by government Resolution No. 737-R of April 19, 2017). One of the most important areas of its implementation is to improve the legal framework for Metrology (Kuzin, 2017).

In the context of the global economy, all technological solutions, including the area of measurement uniformity, have an impact on all of humanity and on economic progress and development throughout the world, especially in countries where high technology is a priority for their economic development.

The legislation of the Russian Federation on ensuring the unity of measurements is based on the Constitution of the Russian Federation and includes Federal law No. 102-FZ of June 26, 2008 on ensuring the unity of measurements, as well as other normative legal acts of the Russian Federation adopted in accordance with them.

The state metrological institutes of the Russian Federation have already begun to work on ensuring the uniformity of measurements in the process of digitalization of the economy (Donchenko, 2018). Issues of metrological support are considered:

- information transfer volumes when evaluating the current distribution of transit traffic flows;
- time and frequency in networks with digital communication and transmission systems;
- spectral energy characteristics of radio signals;
- coordinate-time measurements;
- measurements in the implementation of geodesic and cartographic activities.

In these conditions, it is particularly important to approve the types of newly developed measuring instruments and to certify measurement methods.

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The purpose of approval of the type of measuring instruments is to ensure the uniformity of measurements in the country and release into circulation of suitable measuring instruments. The regulatory framework for these works is set out in the following rules approved by order No. 1081 of the Ministry of industry and trade of the Russian Federation dated November 30, 2009:

- The procedure of testing standard specimens or measurement facilities for the purposes of type approval;
- The procedure for approving the type of standard samples or the type of measuring instruments;
- The procedure for issuing certificates of approval of the type of standard samples or the type of measuring instruments, establishing and changing the validity of these certificates and the interval between verification of measuring instruments;
- Requirements for approval marks of the type of standard samples or the type of measuring instruments and the procedure for their application.

These documents are harmonized with those of the International Organization of Legal Metrology (OIML).

When conducting tests and approving the type of measuring instruments, the following works are performed:

- testing of measuring instruments for type approval purposes;
- making a decision on type approval, its state registration, entering into the State register of measuring instruments and issuing a certificate of type approval;
- testing of measuring instruments for compliance with the approved type;
- recognition of type approval carried out by organizations of foreign countries;
- information services for consumers of measuring equipment, control and Supervisory bodies and public administration bodies.

Tests of measuring instruments for the purpose of type approval are carried out according to a program that establishes the scope and methodology of tests, their duration, and the nomenclature of documents submitted for testing (SGP 121-2013).

According to experts, the transformation of the Russian economy into a digital one will cause an increase in both the volume of data itself and the speed of their processing and transmission. Thus, by 2024, Russia is expected to increase the speed of data transmission in mobile networks of the 5G generation in 100 times, the growth in the number of broadband Internet users – 5 times, the growth in the capacity of Russian data centers – 2 times.

The initial stage of the legislative process for the transformation of Metrology in Russia was legislative initiatives to amend the 102-FZ "on ensuring the uniformity of measurements". The changes set the priority of digital registration of metrological activity results. Work in this direction is carried out taking into account international experience and in close cooperation with specialists of the national metrological Institute of Germany PTB (Physikalisch-Technische Bundesanstalt) (Schulz, 2005).

At the international scientific and practical conference "Metrology of the digital economy", held in May 2018 in Moscow, an agreement was reached to expand cooperation between Russian metrological

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institutes and PTB in the development of digital calibration certificates, the creation of a metrological "cloud", the use of "blockchain" technologies and methods of virtual testing of measurement software.

5.2. Assessment of the role of metrology in the components of quality of products and services

The quality infrastructure includes Metrology, standardization, and accreditation. Strengthening the relationship between these three components is a prerequisite for successful digital transformation of the economy.

Issues of metrological support for mandatory conformity assessment, which includes such forms of confirmation as Declaration of conformity and mandatory certification, are important for the accreditation of testing laboratories and centers.

The level of metrological support is a determining factor in the reliability of test results, and the presence of:

- approved and verified testing programs and methods;
- equipment and devices that have passed metrological verification for measuring instruments;
- personnel certified for testing.

Measuring equipment is all measuring instruments, standards, test equipment, auxiliary equipment necessary for testing. The general requirements for measurement processes, as well as metrological confirmation processes for specified equipment, are defined by ISO 10012:2003. In 2008, the corresponding state standard (State Standard R ISO 10012-2008, 2008) was approved and put into effect in Russia.

A more complex procedure used in cases where the measurement process is complex is the measurement process control system, which is understood as the monitoring and analysis of the measurement process data in combination with corrective actions aimed at maintaining the continuous finding of the measurement process within the established requirements. All the features of this system from a procedural point of view are set out in the ISO 10012 standard. Corrective actions may include, in particular, reducing the intervals between verifications, repairing or replacing an unstable or unreliable instrument, increasing the measurement time, the required accuracy, and so on.

The main provisions related to metrological support of tests have been developed in the new version of the international standard ISO/IEC 17025:2017. This document is the basis for implementing quality management systems in testing and calibration laboratories, as well as for evaluating their competence during accreditation. In Russia the state standard (State Standard ISO/IEC 17025-2019, 2019) acts as a similar document.

The main provisions specified in regulatory documents that are subject to verification when certifying quality management systems include:

- testing, measuring and auxiliary devices;
- procedure for preparing for tests and measurements;
- rules for processing and registration of test and measurement results;
- permissible errors of measurement results and accuracy of test results.

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The results of tests are issued in the form of protocols, where the parameter of the object under test is expressed in the appropriate units of measurement, and its regulated value and tolerance for the parameter meet the requirements of regulatory documentation or technical conditions. It is obvious that a reliable result contributes to the harmonization of mandatory conformity assessment processes for mutual recognition and trade facilitation between countries.

Certification of services rendered is a more complex process. But it also involves carrying out measurements and tests. Therefore, without appropriate testing laboratories, and, consequently, without the procedures outlined above, it is impossible to do.

6. Findings

Changes in measurement technology require a serious rethinking of the legal framework in the field of metrology. In order to study the expected economic benefits and advantages of adopting a more modern, flexible legal framework in the future, it is necessary to determine the current economic value of metrology.

Professional metrologists and measurement experts can quickly point to some key examples that highlight the importance of metrology, such as measurement accuracy and reliability. It is much more difficult to quantify the economic value of metrology, which provides the basis for determining the level of public investment in its infrastructure. The metrology infrastructure includes standards and scientific equipment, a highly skilled workforce, research, logistics, and accreditation (Filho, 2017). Reliable metrological infrastructure creates significant costs for the government.

Certain advantages that metrology provides to the economy can be measured by calculating the values of indicators such as gross domestic product / gross national product for goods and services that are sold based on measurement (Birch, 2003). Although these types of studies determine the importance of metrology for society and the economy, there is no quantitative indicator of the benefits derived from metrology (Filho & Gonçalves, 2015). These trade economic benefits are not the only benefits that metrology offers to the economy. There are also economic advantages associated with accurate measurement in research and innovation. Metrology plays a vital role in supporting health, the environment, safety and social well-being. The significance of metrology and its role in supporting measurements in these sectors is much more difficult to quantify.

The Internet and mobile telecommunications are another fast-growing sector. The advantages of accurate measurements in this sector are reduced transaction costs associated with network bandwidth, data transfer rate restrictions, and traffic routing.

7. Conclusion

There is a direct relationship between product quality and measurement quality. Measurements of the quality parameters of materials, components, and technological processes largely determine the high quality of products and services provided. When solving the problem of measurements, an important place is given to their quality, which is understood as a set of properties of measurement States that cause the results to be obtained with the required accuracy characteristics in the required form and in a specified time.

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The demand for high-tech products requires conformity assessment at all stages of their life cycle, and scientific and technological progress requires ensuring the uniformity of measurements, both in individual countries and internationally. Almost any physical characteristic can be measured today, regardless of the range of variations. In the Russian Federation, billions of measurements are made every day, and more than 4 million people are already doing this professionally. Measurements account for up to 10-15% of all social work expenditures, while 50-70% of total social work expenditures are for the production of electronic and precision products. In modern electronic systems, up to 60-80% of the cost is made up of materials, components and final measurements of product parameters.

The development of digital economy metrology is at the very beginning of the road and it is obvious that solving the tasks set in this area will require significant intellectual investment. At the international level, metrology for digitalization is moving forward intensively through research programs and the creation of working groups, the development of regulatory and administrative databases for cloud computing, big data, it security and machine learning.

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