

The Role of Indigenous Medical Devices and Equipment Development in Medicine

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Abstract

The market of modern medical hardware-software complexes and other innovative devices remains a promising sector of the contemporary economy, despite the spread of the coronavirus infection in 2020. The most significant feature of this market is driven by the advancement of digital medicine and prospective solutions for human health maintenance.

In the modern state, the healthcare industry as a whole, and specifically, the medical technology sector, stands as a priority direction for development.

The relevance of this article is tied to the new qualities of the medical equipment market amidst the development of economic globalization processes, digitalization, and factors of scientific and technical progress, as well as the state's policies to support competition, competitiveness, and innovative industrial growth within the medical equipment field. Trends and prospects in the development of the global medical equipment market serve as a guideline for countries undergoing active market reforms, including the Republic of Uzbekistan. Therefore, studying international experience will aid in identifying and formulating recommendations for enhancing the functioning of the considered sector, thereby fostering the development of domestic competitive industries, which underscores the practical significance of this work.

Keywords: *Medical hardware-software complexes, medical devices, medical product economy, domestic production, competitiveness, digitalization, digital.*

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1. Introduction

Economic Indicators Associated with the Growth of Modern Technology Sectors: An Interconnected Framework

The economic indicators of industries related to the growth of all facets of contemporary technology are intrinsically interconnected, akin to a bridge. This discussion pertains to the extensive integration of information technology across various sectors of the economy, including healthcare. Medicine, in and of itself, has become an integral component of modern economics, primarily due to the substantial costs associated with healthcare in the context of global nations.

First and foremost, in our era, medicine functions not merely as a vital aspect of life but as an integral constituent of the economy. It is crucial to underscore the integration of innovative technologies and communication within modern society.

One of the hallmarks of medical innovation is the adoption and advancement of medical hardware-software complexes and devices. These two technologies, in particular, have the potential to positively impact the global economy.

Artificial intelligence, the Internet of Things (IoT), Telegram chatbots, and other remote technologies represent extraordinary breakthroughs in contemporary medicine. Thanks to these innovations, the field of medicine is embarking on extensive endeavors in areas such as telemedicine [1,2].

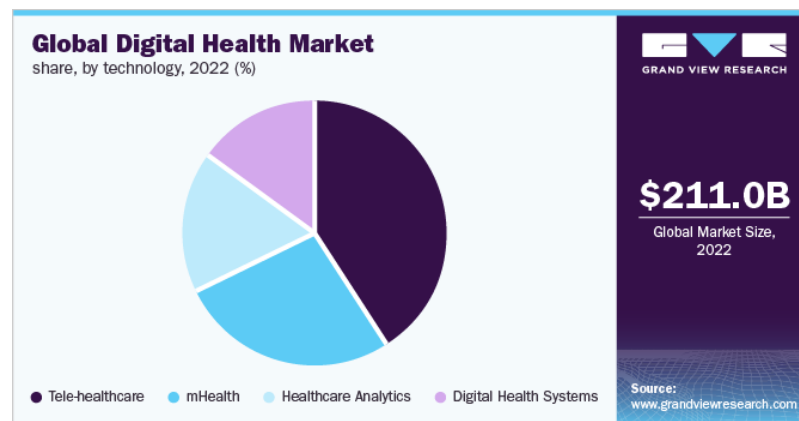


Fig. 1. The global market size of digital healthcare in 2022

According to experts' forecasts, in 2023, the size of venture financing in digital healthcare is expected to reach \$10 billion, which is lower than the level in 2019. Delve Insight predicts that by 2027, the global market for digital healthcare will exceed \$486 billion, with North America dominating during the forecast period. Increased competition is also expected, as many companies are investing in emerging markets for future growth.

The global market for medical robots will grow to \$21.65 billion by 2026 at an average annual growth rate of 18.1%. The primary driver of this growth is the demand for precise and accurate laparoscopic surgeries, which medical robots are effectively capable of performing [6,7].

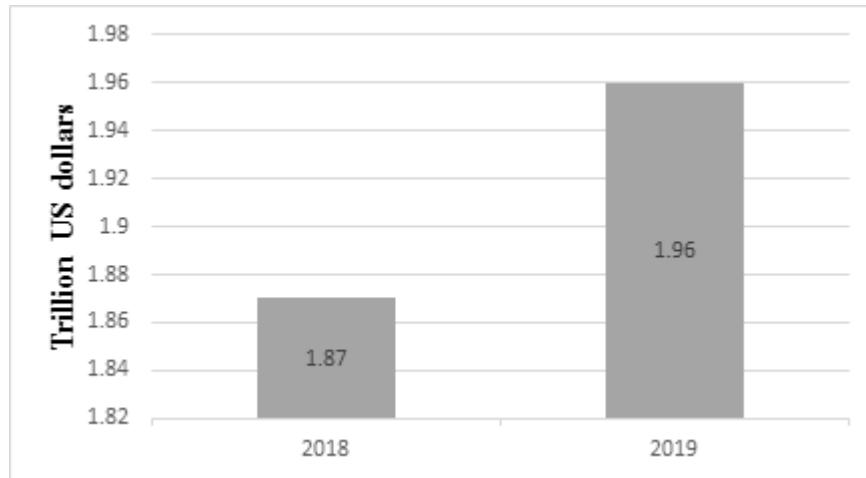


Fig. 2. Global Healthcare Technology Market Size for 2018-2019.

2. Modern diagnostic apparatus and devices: progress and development

2.1 The primary factors influencing this market are as follows:

Demographic Factor: The aging population and the global increase in life expectancy have a significant impact on the development of the medical industry.

Economic Factor: The funding of both public and private healthcare institutions is directly tied to the economic situation in a country. The rising cost of healthcare services worldwide continues to reduce their accessibility.

Socioeconomic Factor: The standard of living, coupled with the prevalence of diseases, determines the demand for medical services in developed and developing countries. The high cost of treating severe illnesses necessitates increased attention from government authorities towards disease prevention and early detection.

Scientific and Technological Progress Factor: Advances in medical technology and data management contribute to the development and dissemination of innovative diagnostic and treatment methods.

The global medical device market is one of the most dynamically evolving sectors, forming a global healthcare industry. Medical technologies are a prominent part of this sector. Currently, the market growth rate is around two percent. The global market volume for medical equipment is approximately \$350 billion USD. The majority of the market is concentrated in industrial centers such as Germany, China, Italy, Japan, and the United States. The largest market by size is the American market, with growth rates in this segment closely mirroring global trends. The European region constitutes the second-largest market by size, and the Asia-Pacific region is the fastest-growing market [10,11].

Detecting serious diseases at an early stage can slow down their progression. Modern diagnostic methods effectively address this task. Preventive medical examinations conducted using endoscopic equipment, laboratory instruments, and devices for functional diagnostics aid in identifying even the slightest deviations in physiological processes and enable timely corrections. Such an approach to the treatment of “diseases of the century” – such as cardiovascular, oncological, and neurological diseases – contributes to the deceleration of

pathological processes and substantial improvements in the quality and duration of patients' lives [12,13].

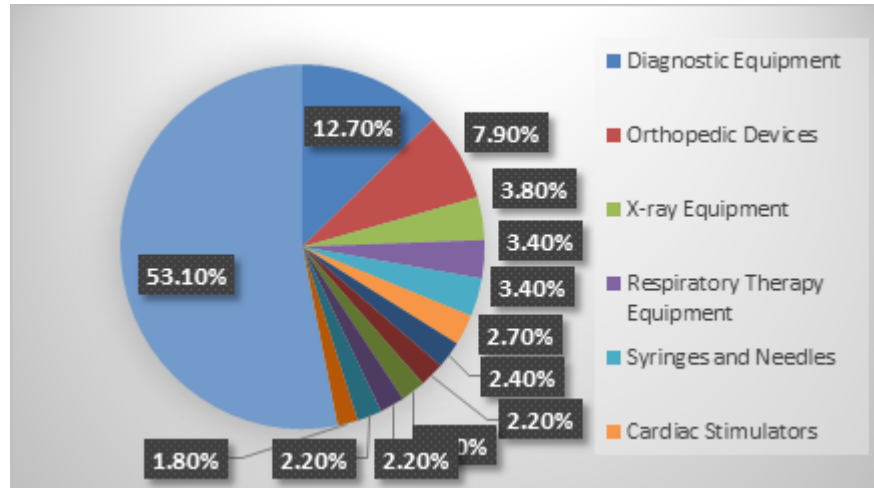


Fig. 3. Demand for medical equipment and medical devices

Special attention is always given to medical diagnostic equipment at exhibitions in the field of medical technology. These devices are in high demand in various healthcare facilities. Manufacturers of medical equipment regularly introduce new versions of diagnostic tools. Thanks to their improvements, the equipment becomes more precise, faster, and more reliable. Constantly updating diagnostic equipment is a prerequisite for the effective functioning and development of any medical institution.

Modern research also focuses on the development of new medical technologies. Among them, DNA analyzers, universal spectrometers, and tools for conducting comprehensive functional studies stand out [14,15].

2.2 Medical Technology Industry in 2023

To conduct in-depth research on top trends and startups in the field of medical devices, we analyzed a sample of 4,063 global startups and companies scaling their businesses. The result of this research is innovative data based on insights that enhance strategic decision-making, provide an overview of new technologies, and startups in the field of medical devices. These research findings were obtained through the StartUs Insights Discovery Platform, based on Big Data and artificial intelligence, covering over 2.5 million startups and companies worldwide. As the largest resource for data on emerging companies, this SaaS platform allows you to quickly and comprehensively identify relevant startups, new technologies, and future trends in the industry.

On the innovation map below, we can review the Top 10 trends and innovations in the field of medical devices that impact 4,063 companies worldwide. Additionally, the innovation map in the field of medical devices presents 20 selected startups, all working on new technologies to advance this sector [16,17].

Top 10 Trends in Medical Devices:

1. Wearable Devices.
2. Medical Robots.
3. Immersive Technologies.

4. 3D Printing.
5. Internet of Medical Things (IoMT).
6. Artificial Intelligence (AI).
7. Cybersecurity.
8. Minimally Invasive Devices.
9. Medical Waste Management.
10. 5G Technologies.

5G Technology plays a significant role in enabling efficient communication between medical devices and healthcare infrastructure. Low network latency during surgeries involving augmented reality contributes to enhanced surgical outcomes. This is why medical device manufacturers are integrating 5G technology into their connected products. With its high bandwidth and reliability, 5G technology minimizes the time delay between data collection and processing and enables medical professionals to create.

3. Research findings: application of machine learning algorithms for the development of domestic innovative medical devices

Modern medical devices must have a clear understanding of the speed at which they can accomplish their assigned tasks and accelerate their workflow. Based on the aforementioned technologies, we propose the utilization and implementation of machine learning algorithms, where we highlight their effectiveness as follows:

We conducted an analysis of several neural network algorithms and selected four neural network algorithms:

k-Means

Support Vector Machine

Artificial Neural Network

Random Forest

For each algorithm, we performed the dataset training process and assessed their accuracy. The algorithm with the highest accuracy will be chosen.

k-Means Algorithm:

The k-Means algorithm is used for classification and can also solve regression prediction problems. It is primarily used for solving industry problems through predictive classification.

How the k-Means Algorithm Works:

The algorithm uses “feature similarity” to predict the values of new data points, meaning that a new data point will be assigned a value based on how closely it resembles points in the training dataset.

The k-Means algorithm can be understood through four steps:

Step 1 – To implement any algorithm, we need a dataset. This, during the first step of KNN, we load both the training and test data.

Step 2 – Next, we need to select a value for K, which represents the nearest data points. K can be any integer.

Step 3 – For each point in the test data, do the following:

Step 4 – End

Support Vector Machine (SVM) Algorithm:

The Support Vector Machine algorithm is a member of supervised learning algorithms, used for both classification and regression analysis. It belongs to the family of linear classifiers. One of its key properties is the continuous reduction of empirical classification errors while increasing the margin. SVM is also known as the maximum margin classifier.

Artificial Neural Network (ANN) Algorithm:

Artificial Neural Network (ANN) is a mathematical model and hardware or software implementation designed to mimic the organization and functioning of neural networks in living organisms. ANN is not programmed but rather trained. Training involves finding the coefficients of connections between neurons. The ability to learn is one of its advantages over other algorithms [20,21,22].

ANN is also used for prediction. This occurs after training, where the neural network can forecast future values based on several previous values and current inputs. Prediction is employed in cases where past changes in a given parameter significantly influence future changes. For example, disease prediction of various kinds.

Random Forest (RF) Algorithm:

The Random Forest algorithm, also known as the "Random Forest," is a versatile machine learning algorithm. It operates by using an ensemble of decision trees and is used for both classification and regression tasks. This algorithm is highly flexible and can be applied to solve various problems in the field of machine learning.

4. Analysis of the most current medical technologies (medical devices) in medicine

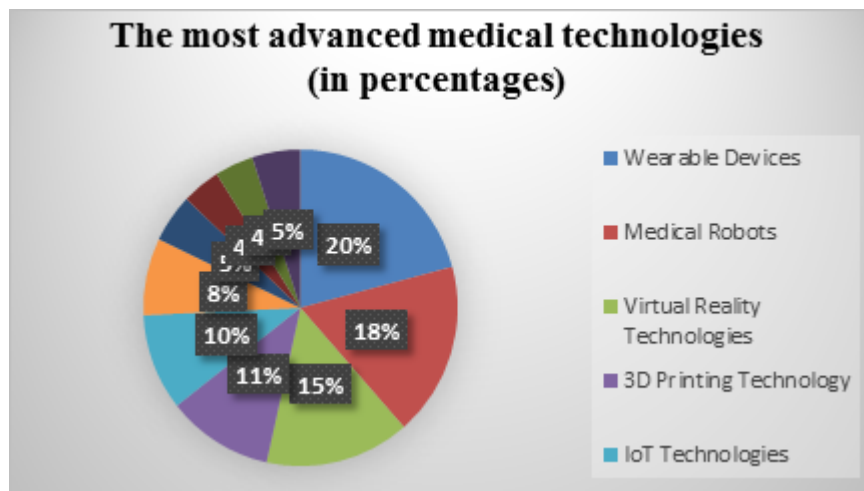


Fig. 4. The most advanced medical technologies (in percentages)

Table 1. Analysis of diagnostic software and hardware complexes, devices, and apparatuses at present.

№	Types of Medical Computer-Aided Systems (CAS)	Device or CAS (Computer-Aided System) Name	Cost, (US dollars)	Characteristic	Diagnostic Accuracy, Percentage (%)
1	Computed Tomography (CT) Scanner	Revolution CT	1 824 198,18	Whole-Body Imaging	98
2	Magnetic Resonance Imaging (MRI) Scanner	Signa Pioneer 3,0	2 594 950	Total Digital Imaging (TDI)	90
3	OFEK-CT Scanner	Discovery NM/CT 870 CZT	1 556 970	Whole-Body Scintigraphy	90
4	Angiographic System	Innova IGS 5 Autoright	836 210,18	Automated Calculation System	80
5	X-ray Surgical System	OEC Elite CFD	94 526,63	Combined X-ray Fluoroscopy and Endoscopy Suite	90
6	Densitometer	Lunar iDXA	44 121,21	Precise measurements of bone tissue, allowing for the tracking of even subtle changes.	86
8	General-Purpose Ultrasound Devices	Logiq E10	63,302	Console and sensor materials are resistant to aggressive cleaning agents.	99
9	Portable Ultrasound Device for Cardiology and Vascular Research	Vivid IQ	22 264,67	10% lighter and thinner than its predecessors in the Vivid series.	90
10	Ventilator (Mechanical Ventilation) Device	Carescape R860	16 607,68	User-oriented and easy to operate.	80
11	Incubator	Giraffe INC	12 455,76	Innovative incubator features assist in maintaining patient growth and stability.	99
12	24-Hour Blood Pressure Monitoring System	Tonoport V	2 802,55	Customization of night and day modes, as well as protocol selection.	95
13	Electrocardiograph (ECG)	MAC 2000	2000	Automatic ECG registration	90

Scientists in Uzbekistan have embarked on the development of the first domestic turbine-based artificial lung ventilation apparatus (ALV). The release of the experimental model of this new apparatus is planned for late 2023 or early 2024. The ALV will incorporate artificial intelligence, allowing the device to autonomously control the ventilation level based on the degree of lung

damage in the patient. The apparatus will have the capability to configure therapeutic and auxiliary ventilation modes [2,3,4].

5. Conclusion and Recommendations

The growing medical equipment market is a key driving factor in the market.



Fig 5. Medical device contract manufacturing

In conclusion, it is worth noting that the increasing incidence of various infectious diseases requires immediate attention to the development of medical devices and equipment. It is essential to explore new opportunities and attract foreign investments for the development of domestic medical technologies to enhance the comfort and quality of healthcare services in the country.

We propose developing systems and devices for the home healthcare system, especially given the recent increase in infectious diseases and the need for disease prevention. In recent years, competitiveness, innovative ideas, and startups have become increasingly important. Through such projects and investments, we can initiate the development of domestic medical devices.

From an economic perspective, it becomes evident that any product or device that becomes domestically produced can occupy a significant place not only in the international market but also in our republic. Here, the focus should be on cost reduction and patient comfort, considering their location and needs.

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