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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 economy.

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 endeavours in areas such as telemedicine [1,2].

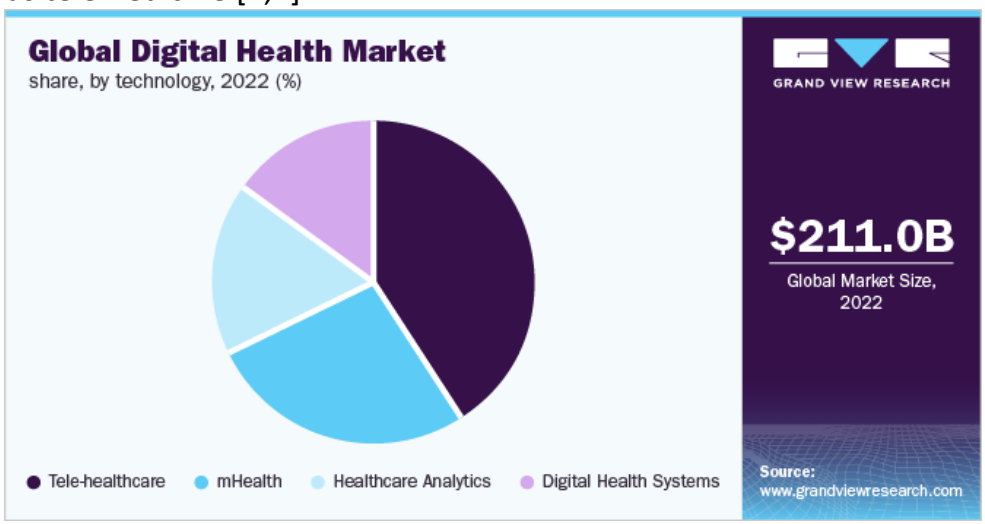


Figure 1. The global market size of digital healthcare in 2022:

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.

According to Arizton’s data, the market for digital healthcare and wellness technologies will grow at an average annual growth rate of 22% and is projected to reach $1.1 trillion by 2028. Analysts attribute this promising growth to the increasing demand for telemedicine and the active adoption of AI and data analytics (such as remote patient monitoring systems) in healthcare.

According to Research and Markets forecasts, the global telemedicine market will grow at an average annual rate of 21.6%, reaching $539.73 billion by 2029. Analysts identify key drivers of this market as the increasing prevalence of chronic diseases combined with an ageing population, a shortage of medical professionals, and growing public awareness of the benefits of telemedicine.

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].

The volume of the global medical technology market underscores the need for special attention to patient prevention and treatment at the level of government policy, to advance toward a robust healthcare system. The demand for medical equipment is directly dependent on a state's policies in this sector, as well as the population's ability and willingness to adhere to healthy lifestyle rules and norms. [8,9].

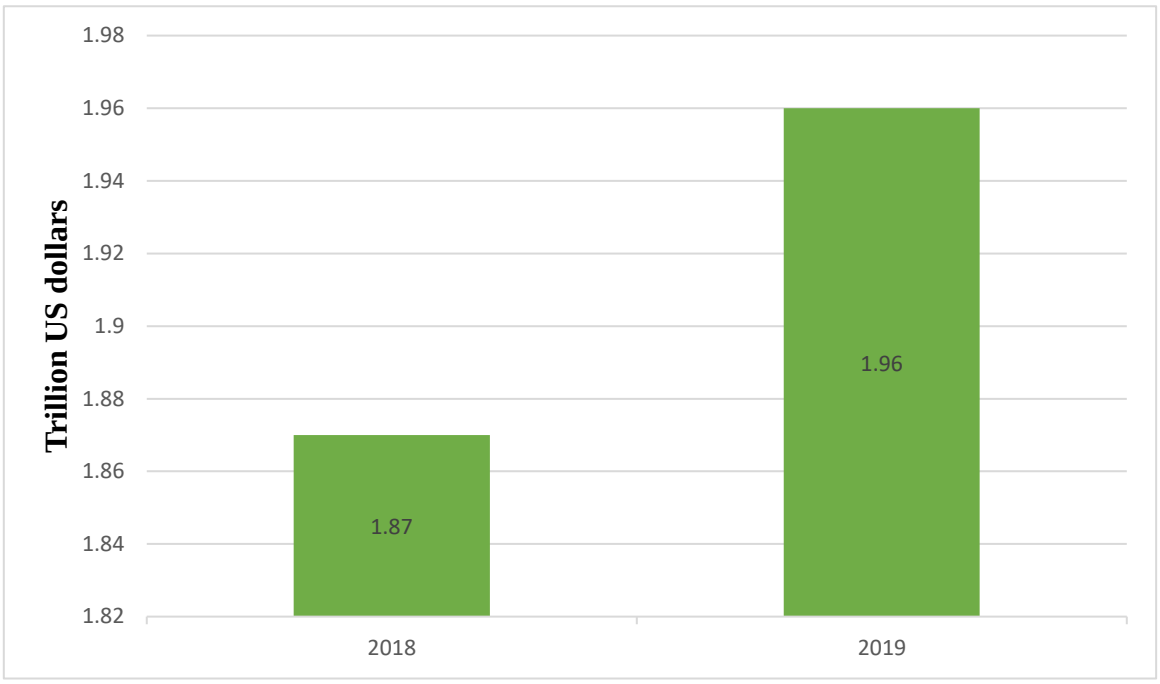


Figure 2. Global Healthcare Technology Market Size for 2018-2019.

The primary factors influencing this market are as follows

Demographic Factor: The ageing 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 per cent. The global market volume for medical equipment is approximately USD 350 billion. The majority of the market is concentrated in industrial centres 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].

Modern diagnostic apparatus and devices: progress and development. Modern medical apparatus and devices serve as the primary means for disease prevention and the preservation of human health. Medicine possesses a vast array of medical technology to facilitate treatment through the use of various devices. Without the use of specialized equipment, it is impossible to perform any therapeutic procedure.

The diagnostic stage represents the first and most critical phase of the health recovery process. The reliability and accuracy of the diagnosis significantly influence the

justification and effectiveness of all subsequent measures, including medication therapy, physiotherapy, or surgical intervention.

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].

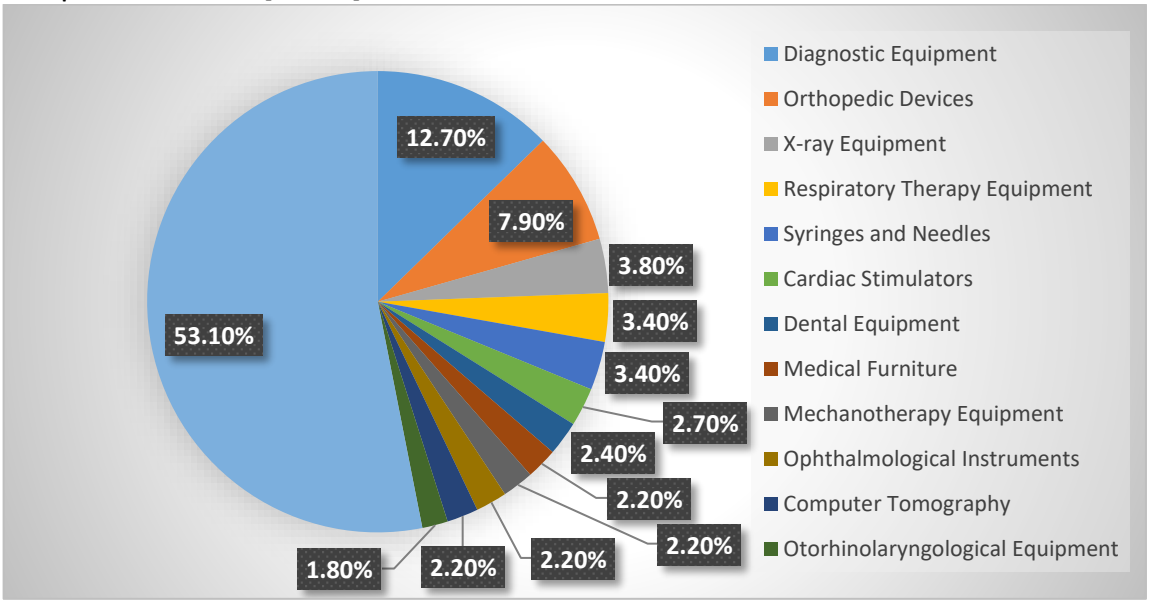


Figure 3. Demand for medical equipment and medical devices.

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.

High-quality equipment is of particular importance to diagnostic centres specializing in precise patient examinations and the creation of highly accurate diagnostic profiles. Many patients are referred for additional examinations to specialized centres or laboratories to refine their diagnosis, so the requirements for the technical equipment of such institutions must be of the highest standard.

Today, a relevant direction in the development of diagnostic equipment is the creation of rapid assessment tools that can be used even without specialized medical education. Portable devices enable volunteers or non-professional users to provide first aid to the sick in home settings.

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].

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.

Wearables: Advancements in Miniaturization of Circuits Enable the Development of Various Wearable Devices, Such as ECG Monitors, Biopatches, Smart Glasses, Psychological Monitoring Devices, and Others. They collect data on users’ health and vital signs, necessary for more effective medical care and health monitoring. Additionally, this allows doctors to provide remote consultations, while continuously monitoring the patient’s condition. Thus, wearable medical devices provide non-invasive diagnostics and enhance the efficiency of prognosis during medical emergencies.

The company Aidmed is developing a portable device worn on the chest. The Polish startup Aidmed is developing a device for recording physiological parameters such as blood pressure, temperature, and electrocardiogram (ECG). It then uses artificial intelligence to convert this data into information useful for assessing the patient's condition.

The U.S. startup Gate Science offers a wearable device for pain control. The startup's product, RELAY, combines the capabilities of pharmacological blockade and neuromodulation in one multimodal device. Additionally, the companion app from Gate Science allows patients to control these signalling mechanisms. The startup's solution offers an alternative to narcotic drugs for pain relief after surgical procedures.

Medical Robots. Medical robots replace traditional surgical methods for more precise intervention and patient safety. For example, robotic laparoscopic surgeries provide smaller incisions, reduced blood loss, and faster patient recovery. On the other hand, surgeons benefit from improved ergonomics and dexterity compared to traditional laparoscopy. Now,

hospitals and clinics also use robots for disinfection, allowing medical staff to focus on patient interaction. Finally, micro-robots and nanorobots enable targeted therapy.

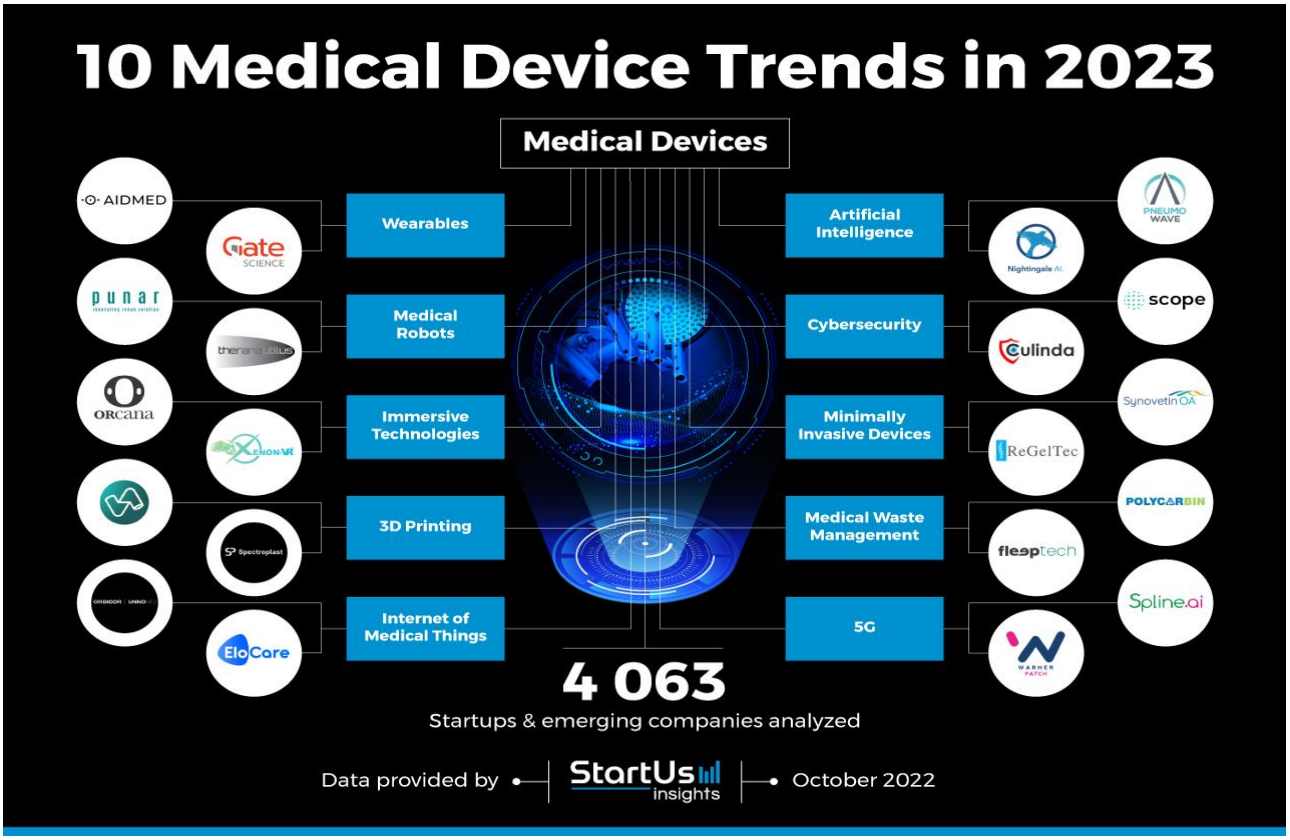


Figure 4. Manufacturers of the most advanced medical technologies

Indian startup Punar offers a portable robotic exoskeleton. The Punar exoskeleton, a device for training arm muscles, utilizes proprioceptive neuromuscular facilitation (PNF) techniques to train paralyzed arms in stroke patients. It also provides quantitative information on patients’ recovery, expediting the rehabilitation process.

Indian startup Theranautilus provides nanorobots for oral care. The magnetic robots of the startup, BIO BOTS, contain biologically active components capable of reaching dentin tissues. They permanently eliminate tooth hypersensitivity and contribute to their restoration. Dental professionals use the startup's robots to automate intelligent drug delivery for oral cavity diseases.

Immersive Technologies. Advancements in medical devices create images and videos with higher resolution, but they remain static. Immersive technologies overcome this limitation and provide a first-person view. Startups use virtual reality (VR), augmented reality (AR), and extended reality (XR) in the production of medical devices to enhance product design. These technologies also improve the quality of healthcare delivery and rehabilitation.

Artificial Intelligence. Artificial intelligence enhances the processing and analysis of large volumes of data collected by medical devices. Using individual health data, companies employ artificial intelligence to detect diseases or the onset of medical conditions. Additionally, artificial intelligence enables predictive analysis and treatment effectiveness tracking. Medical device manufacturers also integrate artificial intelligence technologies,

such as computer vision, to expedite diagnostics and robotic surgical capabilities. AI is also applied for automating and optimizing manufacturing processes.

Taiwanese startup Nightingale offers an intelligent bracelet for infection prediction. The AI-equipped wearable device, HEARThermo, continuously monitors changes in body temperature and heart rate. HEARThermo’s AI generates an analytical report, enabling the early prediction of infections. This allows healthcare professionals to track suspicious cases during epidemics.

British startup PneumoWave develops a smart chest-worn biosensor. The biosensor captures breathing data, and the startup’s platform analyzes them using machine learning algorithms. This improves the monitoring of chronic obstructive pulmonary disease (COPD). It detects early signs of deterioration and notifies patients and physicians. This allows for prompt treatment initiation and reduces or minimizes hospitalization.

Cybersecurity. Medical institutions are one of the primary targets of malicious hackers. Furthermore, the adoption of cloud solutions and connected medical devices makes the industry more vulnerable to cyberattacks. Startups offer cybersecurity solutions tailored to medical devices. These solutions enable manufacturers, hospitals, and patients to promptly detect anomalies in the network or devices, reducing risks. By safeguarding medical devices from intentional failures, cybersecurity solutions prevent threats to patients’ lives.

US startup Culinda offers comprehensive medical device cybersecurity management. It utilizes artificial intelligence to prevent cyberattacks on medical devices, providing real-time protection. Additionally, the startup uses blockchain to ensure continuous access to device information, such as communication sources, device inventory, and more. Culinda’s solution allows hospitals to securely manage all medical assets.

US startup Scope Security provides cloud-based predictive cybersecurity analytics. The Scope OmniSight platform utilizes artificial intelligence to analyze logs from thousands of systems to detect anomalies, prioritizing threats in the enterprise. This allows hospitals to automate threat detection and response regarding all information systems, medical devices, and electronic health records (EHR).

Minimally Invasive Devices. Minimally invasive surgery addresses issues with invasive procedures such as infection risk, large scars, and slow recovery times. New techniques and devices enable surgeons to make smaller incisions in procedures like endoscopy, laparoscopy, and robotic surgeries. Startups integrate miniaturized sensors into device tips, providing real-time feedback to operating physicians, e.g., through tactile vibrations. Moreover, minimally invasive devices reduce patient trauma, discomfort, infection risks, recovery times, and healthcare costs.

US startup ReGelTec develops injectable hydrogel devices. The startup's Hydrafil system utilizes hydrogel technology for intradiscal augmentation of the nucleus pulposus in the form of a viscous liquid. The liquid then solidifies into a cohesive hydrogel inside the annulus fibrosus, effectively sealing the site and minimizing the risk of expulsion. Doctors use this minimally invasive device to create spinal implants for patients with chronic back pain.

Exubrion Therapeutics, a US startup, provides Synovetin OA, a minimally invasive veterinary device. It consists of micro-particles of tin radiopharmaceutical. Physicians introduce these particles into joints, where they deactivate inflammatory macrophages and

treat synovitis without side effects. This enables veterinarians to conduct targeted therapy for osteoarthritis.

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 real-time holographic images for more precise diagnostics.

Indian startup Spline offers the integrated healthcare platform Dr. Spline, which utilizes 5G and artificial intelligence. This platform provides a conversational interface, predictive image and video analysis, and data protection for any medical device. It unifies the entire healthcare ecosystem, ensuring quick and easy access to solutions such as surgical preparation using augmented reality.

British startup M2JN develops a 5G-connected medical patch. The portable WarnerPatch device performs remote monitoring of vascular health by measuring soft tissue health in the region. Thanks to 5G connectivity, the startup's platform continuously receives real-time data from these patches, sending symptom reminders. This allows doctors to more closely monitor vascular conditions, such as diabetic ulcers and post-surgical recoveries.

These innovations in 5G and medical technologies enhance connectivity and data processing, ultimately contributing to more precise patient diagnosis and treatment [18,19].

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 analyzed 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.

The k-Means algorithm possesses two properties:

1. Lazy Learning Algorithm: This algorithm has a specialized training phase and utilizes all data for training during classification.

2. Non-parametric Learning Algorithm: It is considered a non-parametric k-nearest Neighbors learning algorithm because it makes no assumptions about the underlying data.

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

KNN falls into the category of supervised learning algorithms. This means there is a dataset with labelled training measurements (x, y), and the goal is to discover the relationship between x and y. The objective is to identify a function h: X→Y, such that given an unknown observation x, h(x) can accurately predict the corresponding output y (1,2).

For distance metrics, the Euclidean metric will be utilized.

$$d(x, x') = \sqrt{(x_1 + x_1')^2} + \cdots + \sqrt{(x_n + x_n')^2} \quad (1)$$

The input x is assigned to the class with the highest probability.

$$P_{(y=j|X=x)} = \frac{1}{K}\sum_{i\in A} I(y^i = j) \quad (2)$$

For regression, the method remains the same. Instead of nearest neighbour classes, we will consider the target values and find the target value for an unseen data point by taking the mean, median, or any suitable function.

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.

In the SVM algorithm, it is easy to create a linear hyperplane between classes. The algorithm employs the Kernel Trick method, which takes a low-dimensional input space and transforms it into a higher-dimensional space, thus converting an unsolvable problem into a solvable one.

Artificial Neural Network (ANN) Algorithm:

An 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.

The training process occurs in two forms:

- Supervised Learning
- Unsupervised Learning

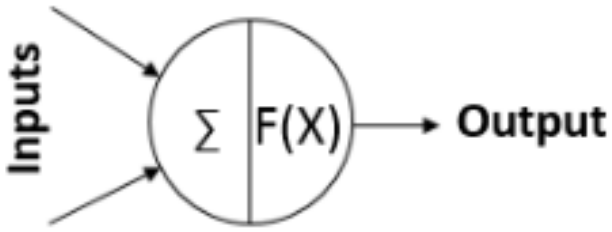


Figure 5. A simple neuron

Activation of the incoming signal is achieved using the activation function F(X). Activation functions can include sigmoid, ReLU, tanh, and so on. In this example, a sigmoid activation function is used in the nodes of the layers.

$$F(X) = \frac{1}{1 + e^{-x}}$$

Figure 5 depicts a simple neuron. Now, through a function, the task will be solved. The value of the hidden layer is 1. =(1*0,1)+(1*0,1)+(1*0,1)=0,3.

$$Y_{in} = \sum X_i * W1_{ij}$$

Random Forest (RF) Algorithm:

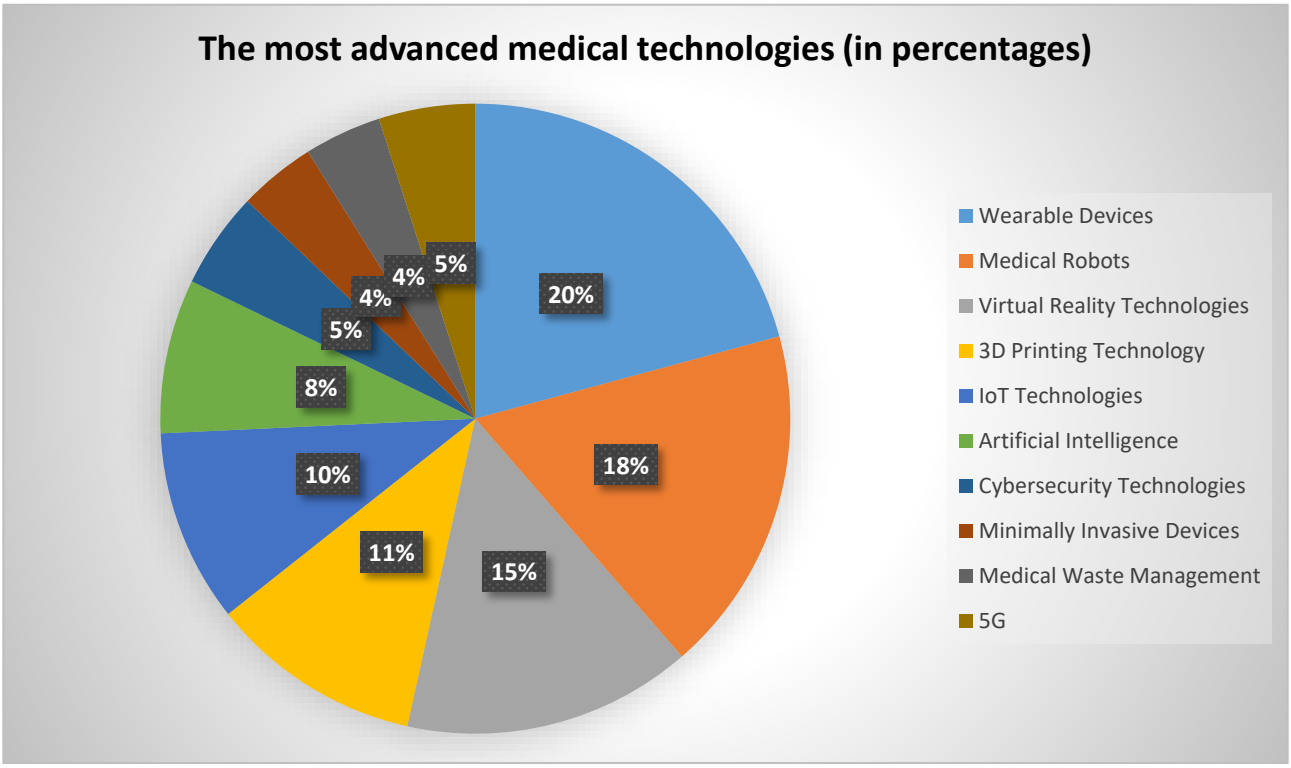
The Random Forest algorithm, also known as the "Random Forest," is a versatile machine learning algorithm. It operates by using an ensemble of decision trees and is used for both classification and regression tasks. This algorithm is highly flexible and can be applied to solve various problems in the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

There are two main types of Random Forest algorithms:

- Classification: Random Forest Classifier
- Regression: Random Forest Regressor

The advantages of the Random Forest algorithm include:

- High prediction accuracy, comparable to gradient-boosting results.
- It does not require extensive parameter tuning and performs well “out of the box”
- It is robust against data outliers due to random sampling.
- Insensitivity to feature scaling and other monotonic transformations.
- It rarely overfits, and adding more trees typically improves the ensemble.
- It can handle data with a large number of features and classes efficiently.
- Effective handling of missing data, maintaining good accuracy even in their presence.
- Suitable for both continuous and discrete features.
- High parallelism and scalability.



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

Figure 6. 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) with High-Resolution Images	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 DXA	44 121,21	Precise measurements of bone tissue, allow for the tracking of even subtle changes.	86
8	General-Purpose Ultrasound Devices	Logiq E10	63,302	Console and sensor materials are	99

№	Types of Medical Computer-Aided Systems (CAS)	Device or CAS (Computer-Aided System) Name	Cost, (US dollars)	Characteristic	Diagnostic Accuracy, Percentage (%)
				resistant to aggressive cleaning agents.	
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 within 10 seconds with a single press.	90

Based on these analyses, it can be inferred that modern medical hardware and software complexes, devices, and apparatuses are key assets in the field of medical economics. The concept of medical economics emphasizes the concentration of resources on enhancing the development and competitiveness of domestic manufacturers.

In our country, the medical industry is under the spotlight of state policy. Efforts are being made in all regions of the country to accelerate the improvement of healthcare services for the well-being and prevention of health issues among the population. This care is undertaken for the sake of the people and society. New modern technologies are being implemented across all regions of the country, demonstrating the reliability of the medical industry in Central Asia.

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].

The concept of the domestic ALV was presented at the First Educational Forum for Anesthesiologists and Intensive Care Specialists in Nukus. Developers aim to create a medical device that surpasses foreign flagship equipment in terms of functionality and capabilities. The project involves designers and engineers from Uzbekistan and Russia.

Developers promise to take into account the needs and operational characteristics of medical equipment in the intensive care units of healthcare facilities in Uzbekistan.

Specifically, the new ALV apparatus will have the ability to operate autonomously, function under critical temperature conditions, regardless of the presence or absence of a centralized oxygen supply system. The work is being carried out by the Republican Center for the Advanced Training of Medical Workers.

Clinical trials of the apparatus are planned to be conducted at City Clinical Hospital No. 1 in Tashkent.

Fig 7. Medical device contract manufacturing

Conclusion and Recommendations

The growing medical equipment market is a key driving factor in the market. For example, according to the World Health Organization (WHO) data as of 2022, there are approximately 2 million different types of medical devices grouped into more than 7,000 common categories. Additionally, in June 2021, Rosti Romania entered into a new contract for the supply of medical equipment for its new production facility. This indicates an increasing demand for contract manufacturing services, driven by the growth of the global medical device market. Some companies, lacking their own manufacturing capabilities for medical devices, prefer to use contract manufacturing, contributing to further market growth.

At the same time, there is a significant factor that hinders the growth of the contract manufacturing market for medical devices, which is the consolidation of the medical equipment market.

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.

List of used literature

1. Medical devices: managing the mismatch. An outcome of the Priority Medical Devices project: World Health Organization, 2012. - 48 p. — ISBN 978 92 4 456404 2.
2. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan, dated March 23, 2018 No. 213 “On approval of the regulations on the procedure for state registration of medicines, medical devices and medical equipment and issuance of a registration certificate.”
3. Decree of the President of the Republic of Uzbekistan, dated October 5, 2020 No. 6079 “On approval of the strategy “Digital Uzbekistan-2030” and measures for its effective implementation.”
4. Resolution of the President of the Republic of Uzbekistan, dated February 17, 2021 No.4996 “On measures to create conditions for the accelerated implementation of artificial intelligence technologies.”
5. Decree of the President of the Republic of Uzbekistan, dated 05.05.2021 No. 6221 “On the consistent continuation of reforms carried out in the healthcare system and the creation of the necessary conditions for increasing the potential of medical workers.”
6. Kokus kina I.V. “International trade. Conjuncture and forecasting of world markets for goods and services.” Workbook-notebook.-Sobs: Publishing House of the Law Institute, 2012.
7. Miklashova E.V. Comparative analysis of the state and development of medical equipment trade markets in Russia and abroad // Modern scientific research and innovation. 2015.
8. Economics of industry markets and state policy: Textbook/N.V. Pakhomova, K.K. Richter. – M.: ZAO Publishing House “Economy”, 2009. – 815 p.
9. E.V. Mamonova Medical Technopark: new opportunities for the development of innovative projects. ECO. 2013. No. 9, p. 15Developing and evaluating digital interventions to promote behavior change in health and health care: recommendations resulting from an international workshop / Michie S., Yardley L., West R., Patrick K., Greaves F. // Journal of medical internet research. – 2017.
10. Goldsmith J. Digital medicine: implications for healthcare leaders. – Chicago: Health administration press, 2003. – 223 p.
11. Krankenhauszukunftsgesetz für die Digitalisierung von Krankenhäusern // Bundesgesundheits ministerium. – 2021.
12. Linebaugh K. Citizen hackers tinker with medical devices // The Wall street journal. – 2014.
13. Natarajan A., Su H.-W., Heneghan C. Assessment of physiological signs associated with COVID-19 measured using wearable devices // Digital medicine. – 2020.
14. Ärzte sollen Apps verschreiben können // Bundesministerium für Gesundheid. – 2020.

15. Yakhshiboyev, Rustam & Muminov, Bahodir. (2023). ME’DA - ICHAK KASALLIKLARINI DASTLABKI TASHXIS QILUVCHI APPARAT – DASTURIY TAMINOTLARINING TAHLILI. 1. 22-34.

16. Yaxshiboyev R., Yaxshiboyeva D. Analysis of algorithms for prediction and preliminary diagnostics of gastroenterological diseases //Central asian journal of education and computer sciences (CAJECS). – 2022. – Т. 1. – №. 2. – С. 49-56.

17. Kudratillayev M., Yakhshiboyev R. Scrutiny the effectiveness of using new telehealth methods for primary diagnostics //Science and innovation. – 2023. – Т. 2. – №. A4. – С. 70-83.

18. Кудратиллаев М. Б. У., Саидова Г. А., Яхшибоев Р. Э. У. РОЛЬ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В МЕДИЦИНЕ: ПЕРСПЕКТИВЫ ДЛЯ ДИАГНОСТИКИ, ЛЕЧЕНИЯ И ПРОГНОЗИРОВАНИЯ ЗАБОЛЕВАНИЙ //Science and innovation. – 2023. – Т. 2. – №. Special Issue 5. – С. 630-632.

19. Yakhshiboyev R. E., Kudratillayev M. B., Siddikov B. N. Forschung von innovativer ausrüstung für die diagnose von magen-darm-erkrankungen //International Bulletin of Applied Science and Technology. – 2023. – Т. 3. – №. 3. – С. 100-105.

20. Yaxshiboyev R. et al. Analysis of the process of deep machine learning based on the results obtained for primary diagnostics of gastroenterological diseases //Central Asian Journal of Medicine. – 2022. – №. 4. – С. 138-147.

21. Yakhshiboyev R. E. HARDWARE-SOFTWARE COMPLEXES FOR THE PRIMARY DIAGNOSIS OF GASTROENTEROLOGICAL DISEASES //Евразийский журнал математической теории и компьютерных наук. – 2023. – Т. 3. – №. 1. – С. 120-127.

22. Yakhshiboyev R. et al. EVALUATION OF MACHINE LEARNING ALGORITHMS FOR GASTROENTEROLOGICAL DISEASES PREDICTION //Science and innovation. – 2023. – Т. 2. – №. A7. – С. 83-94.