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Research paper

Market Research on The Global Bioengineering Analytics and Software Market

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Abstract

The purpose of this study was to analyse current trends and prospects of the global bioengineering analytics and software market. The study identified the key factors that determine the growth of the bioengineering analytics and software markets, as well as their effects on medical and economic processes. The principal findings of the study revealed substantial changes in the global bioengineering analytics and software market. The analytics market, which was worth USD 9 bn in 2022, showed an annual growth rate of 7.6%, which will reach USD 16.3 bn by 2030. The services segment in this area accounts for 54.8% of revenue, highlighting the significance of outsourcing. Predictive analytics, which showed growth of 9% per year, is one of the most promising areas. As for the software market, it was worth USD 16.32 bn in 2022 and is expected to increase to USD 44.72 bn by 2030, with an average annual growth rate of 12.9%. Cloud computing, specifically, revealed considerable growth, increasing its share from USD 9.3 bn in 2023 to USD 25.8 bn in 2033. Investments in bioengineering software are taking place mainly in China and India, where the highest growth rates are 8.3% and 10.3%, respectively, as well as in the United States of America. These findings suggest the rapid growth of the global bioengineering analytics and software market, which highlights their critical contribution to the development of medical services and healthcare innovations, creating new opportunities for improving medical and economic processes.

Keywords: *Data Processing; Innovative Technologies; Medical and Economic Processes; Sector Growth; Trend Forecasts.*

1. Introduction

Advances in technology and the growth of data have substantially changed the way information in the medical field is analysed. Analytics and software in bioengineering play a key role in optimising medical processes, improving the quality of patient care, and developing new treatments. These tools enable professionals to perform in-depth data analysis, which is critical for making informed decisions in the healthcare industry. The use of analytics platforms based on artificial intelligence (AI) and machine learning (ML) opens new opportunities for identifying patterns in medical data and predicting treatment outcomes (Tkachenko et al., 2025).

Despite major advances in the field of bioengineering, some challenges require detailed study and resolution, especially in the context of analytics and software. Firstly, insufficient integration of analytical tools into bioengineering processes can lead to inefficient use of data, which limits the potential for optimising treatment and improving patient care. Secondly, there is a need to standardise approaches to data collection and analysis, as the diversity of methods can complicate the comparison of findings across studies and institutions. Thirdly, limited funding for research in analytics and software in bioengineering hinders innovative development and the introduction of innovative technologies. There is a need to identify gaps in knowledge and practices that may become obstacles to the effective use of analytics and software in bioengineering.

As for analogous studies, Malyshev & Kovalenko (2024) identified the key trends in the global bioengineering market, including segmentation by geographic regions and product types, and identified key factors influencing market dynamics. Specifically, personalised medicine, ML, and AI have become the primary vectors of innovation in bioengineering. Voronkova et al. (2024) emphasised the role of business intelligence as a strategic resource for optimising medical processes in bioengineering, which allows increasing the efficiency of data collection and analysis. It was found that the use of analytical tools and Big Data contributes to informed decision-making and the development of new treatments in the context of digital transformation. Furthermore, Petrov et al. (2019) investigated the implementation of Big Data technologies in the medical industry, focusing on their significance for the development of personalised medicine and improvement of the healthcare system.

On the other hand, Lazim & Ariffin (2024) found that data analytics and AI are key tools for businesses in the context of digital transformation, providing effective management and improving marketing strategies. Ijomah et al. (2024) considered the effects of marketing analytics on small and medium-sized businesses in the context of improving their competitiveness by optimising marketing strategies.

Furthermore, Cornelissen et al. (2020) pointed out the significance of monitoring progress in biotechnology research to support innovation in marketing strategies. The findings showed that learning scenarios allow assessing the impact of changes on the potential for innovation, which can optimise decisions on research investments in biotechnology. As for the study by Hider (2024), its findings emphasised the role of bioengineering in the context of marketing analytics for the development of medical devices that provide high-precision diagnostics and treatment. The researcher pointed out that the integration of data from analytics and the latest technologies allows companies to better understand the needs of patients and adapt their marketing strategies to improve treatment outcomes.

Dündar et al. (2019) considered the prospects for the development of medical biotechnology with a focus on genetics and nanotechnology, which can substantially affect innovations in this area. These aspects emphasise the value of analytics in marketing strategies, which enables companies to effectively adapt their offers and increase competitiveness in the medical technology market. The findings of Chen (2024) demonstrated the use of data analytics in marketing strategies, including market segmentation, analysis of consumer behaviour, and forecasting of market trends. Therewith, the use of descriptive, predictive, and recommended analytics enables companies to gain a deeper understanding of the market. Yu et al. (2019) analysed the development of industrial biotechnology and its transformation into a 'next-generation biotechnology' that should be competitive in the production of chemicals, materials, and biofuels.

These studies identified gaps in the use of analytical technologies to optimise business processes in bioengineering, to integrate personalised medicine into marketing strategies, and to develop models to improve the management of medical technologies. The present study was aimed at identifying key factors influencing the development of analytics and software in the field of bioengineering, which can improve the efficiency of medical services and promote innovation. The objectives of this study were to analyse the current trends in the use of analytics and software in bioengineering, as well as to investigate the effects of these technologies on medical processes.

2. Materials and methods

The study was organised in two phases, each of which aimed to thoroughly analyse certain aspects of the global bioengineering analytics and software market. The first stage involved a comprehensive analysis of the bioengineering analytics market. The focus was on bioengineering and life science analytics, which demonstrated marked growth. This analysis included market segmentation by end-user, which helped to identify which sectors are most involved in this activity. This segmentation included data on medical devices, pharmaceuticals, biotechnology, and services in 2022. Within the framework of the segmentation analysis, the geographical distribution of the market in 2022 was also investigated, which helped to assess its potential in various regions. The analysis included such regions as Europe, North America, Asia Pacific, Latin America, the Middle East, and Africa. For this, data from the Life Science Analytics Market Size, Share & Trends platform was used (Life Science Analytics Market…, 2022).

For a more detailed analysis of market trends, the study segmented the US bioengineering analytics market by use in 2021. Segmentation was performed by such parameters as research and development, sales and marketing, pharmacovigilance, safety and regulatory compliance, and logistics, using data from the Life Science Analytics Market (2024). The market was also analysed by geographic region for 2022-2023, specifically including Asia Pacific, Europe, North America, Latin America, the Middle East, and Africa. This helped to identify specific regional features and specifics of analytical services consumption. Furthermore, the study analysed the development factors, trends, and restraints affecting the market.

The second stage of the study focused on analysing the global bioengineering software market. The focus was on the size of the software market and the role of technology. The study included an assessment of the size of the global bioengineering software market and the share of cloud-based solutions, which demonstrated their growing significance in 2023–2033. For this, a detailed forecast of the software market development in such countries as India, the UK, China, Australia, and Japan was made, which helped to establish which regions will be most active in the implementation of innovative technologies. The average annual growth rate and the main growth factors of these countries were indicated.

The segmentation of the global bioengineering software market by geographic regions in 2023 was another major aspect of the analysis, as it helped to identify the most promising markets for suppliers in North America, Europe, Asia Pacific, the Middle East, Africa, and Latin America. The data for this analysis were taken from the Global Life Sciences Software Market (2024). The market was also segmented by vendor in 2021, which helped to understand the structure of the market and its players. This included a review of companies such as IQVIA, Microsoft, Veeva Systems, Salesforce, Dassault Systems, PerkinElmer Informatics, Systems, Applications, Products (SAP), Oracle, Clario, Statistical Analysis System Institute (SAS). The materials were taken from the Top 10 Life Sciences Software Vendors, Market Size, and Market Forecast 2021-2026 platform (2024). Additionally, the study analysed the factors, trends, and restraints that influence the development of the bioengineering software market.

3. Results

3.1 Analysis of the global bioengineering analytics market

The global analytics market is a prominent part of the modern marketing ecosystem, helping companies to effectively manage data and make informed decisions. The use of analytical tools to analyse consumer behaviour, market trends, and the effectiveness of marketing campaigns is becoming critical to business success. As data volumes and the complexity of life science processes increase, analytical tools play a key role in managing information and predicting outcomes. In this context, the main types of analytics markets are descriptive, predictive, and recommended analytics. Descriptive analytics helps with data visualisation and business intelligence, predictive analytics applies mathematical methods to forecast future trends based on available data, and recommended analytics offers optimised solutions for further actions using advanced analytical processes and tools.

The life sciences analytics market has shown considerable growth, with a volume of USD 9 bn in 2022, with 54.8% of revenue coming from services and 45.2% from software (Life Science Analytics Market…, 2022). The market is expected to reach USD 16.3 bn by 2030, with an annual growth rate of 7.6%. In 2022, the services segment dominated due to the growth of outsourcing and accounted for 57.1% of revenue. In the analytics segment, the highest growth is expected in predictive analytics (9% per year), and in research and development, 9.8%. Furthermore, the on-demand services segment is showing rapid growth due to the development of cloud solutions and remote access (Fig. 1).

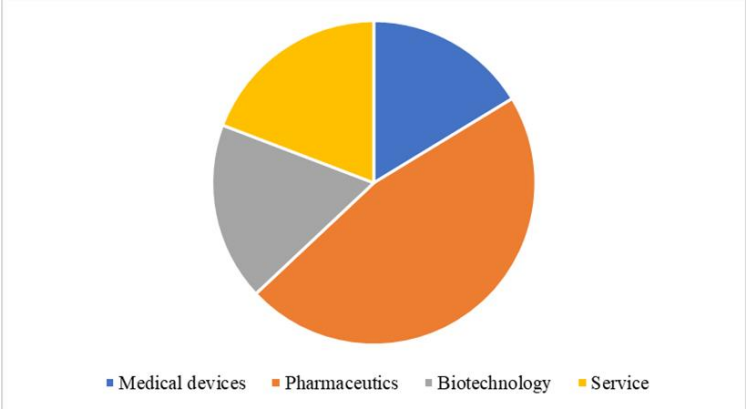

Fig. 1: Segment analysis of life sciences analytics by end user in 2022, %

Source: developed by the authors based on Life Science Analytics Market Size, Share & Trends Analysis Report by Component (Software, Services), by Type, by Application, by Delivery, by End-user, by region, and Segment Forecasts, 2023-2030 (2022).

In other words, segmentation of the life science analytics market by end-user type revealed that pharmaceuticals account for the largest share, followed by services, medical devices, and biotechnology. Such a high share of pharmaceuticals indicates the major role of analytical solutions in the research and development of new medicines, specifically, for the identification of new biomarkers, prediction of drug efficacy, and improvement of clinical trials. The dependence of analytics on the pharmaceutical sector also underscores its strategic significance for the development of personalised medicine, where accurate predictions are required to determine individual treatment plans (Kubiczek & Tuszkiewicz, 2022; Tkach et al., 2021). This opens further growth opportunities in the future as innovative technologies, such as AI and ML, are introduced to help accelerate drug development and improve safety and efficacy.

As for the geography of the life sciences analytics market, it varies considerably depending on the level of technology development, healthcare infrastructure, and demand for innovative solutions in various regions. Each region has its specific features of development of this segment, which is determined by economic, social, and demographic factors, as well as the level of digitalisation in the healthcare industry. For instance, in 2022, North America held a leading position in this market, accounting for more than 32% of revenues due to the development of digital literacy, healthcare IT infrastructure, the emergence of startups, the growth of the geriatric population, and the demand for analytical solutions (Fig. 2) (Life Science Analytics Market…, 2022). Local companies are actively investing in new product development and partnerships to expand their operations. Asia Pacific is expected to show the highest growth rate of 10.3%, driven by rising healthcare IT spending and infrastructure development. Forecast for 2030: North America – 42%, Asia-Pacific – 27.8%, Europe – 25.3%, other regions – 4.9%.

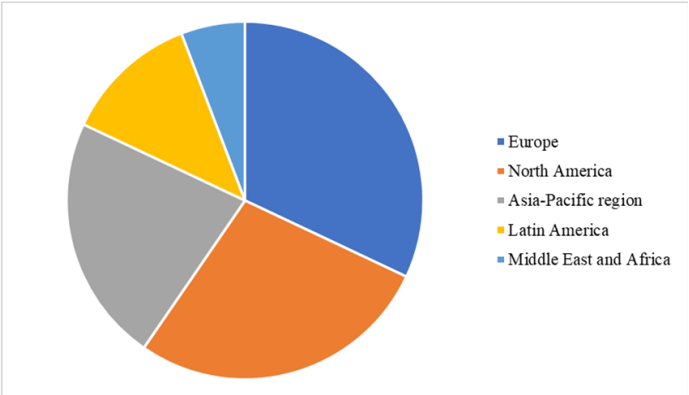

Fig. 2: Segmental analysis of the life sciences analytics market by geographical regions in 2022, %

Source: developed by the authors based on Life Science Analytics Market Size, Share & Trends Analysis Report by Component (Software, Services), by Type, by Application, by Delivery, by End-user, by Region, and Segment Forecasts, 2023-2030 (2022).

According to the segment analysis presented in Figure 2, in 2022, Europe accounted for the largest share of revenue in the biomedical analytics market, surpassing North America and the Asia-Pacific region. This indicates a high level of implementation of analytics solutions in EU countries, particularly in the areas of personalized medicine, new drug discovery, and healthcare system digitalization. North America, in turn, showed a slightly lower but still significant market share, which is explained by the widespread use of analytics platforms in medical research, growing demand for innovative technologies, and significant investments in the digital transformation of medicine. The Asia-Pacific region continued to show high growth rates thanks to the modernization of medical infrastructure, expansion of IT investments, and government support for digital solutions in healthcare. Other regions, including Latin America, the Middle East, and Africa, currently hold a smaller market share but show potential for growth amid healthcare system reforms and the gradual expansion of access to analytics technologies.

At the same time, the bioengineering analytics market has its unique characteristics that are worth considering. Analysing the use of analytical tools in this specific industry can provide valuable insights for further technology development and process optimisation. Pharmacovigilance is the science and practice of identifying, assessing, understanding, and preventing adverse drug reactions after a drug has been released on the market (Balayeva et al., 2020; Barbagallo et al., 2025). In the context of bioengineering, it is crucial for monitoring the safety of innovative drugs, including biological and personalized therapies. Analytical tools in pharmacovigilance are used to identify risks, analyze large amounts of clinical data, and support regulatory decisions (Taushanova et al., 2024; Porkodi & Raman, 2025). For instance, according to the market segmentation by use, the top three places belong to the segments of research and development, sales and marketing,

and pharmacovigilance (Fig. 3) (2024). This indicates that innovation and efficiency in these areas play a key role in the overall growth of the bioengineering analytics market.

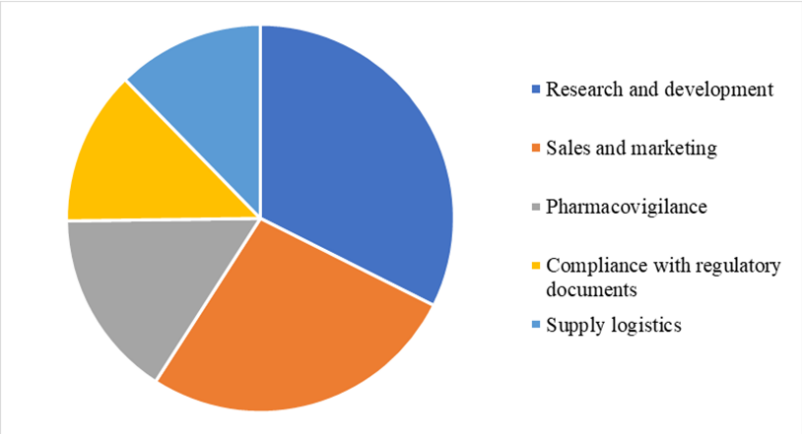

Fig. 3: Segmentation of the US bioengineering analytics market by application in 2021, %

Source: developed by the authors based on Life Science Analytics Market Growth, Size, Share, and Trends (2024).

It turns out that in 2021, the segmentation of the US bioengineering analytics market showed a clear dominance of the research and development segment. This indicates that investment in innovation and innovative technologies continues to be key to growth in this industry. The sales and marketing segment emphasises the significance of commercial strategies for the successful introduction of new products to the market. It is also worth noting that pharmacovigilance and regulatory compliance play a critical role in ensuring safety and regulatory compliance. Supply chain logistics show that effective supply management is a significant aspect of maintaining stability and efficiency in bioengineering. Overall, these findings demonstrate the diversity of applications of analytics in bioengineering, opening new opportunities for process improvement and efficiency gains in various areas.

In the geographical context, North America dominated the bioengineering analytics market with a 40.2% share in 2022 (Gotadki, 2024). Asia-Pacific ranked second with a 29.9% share, followed by Europe with 25.9%, while other regions accounted for 4.0% of the market (Fig. 4). North America is projected to retain its leadership by 2030, with an increase in share to 41.6%, while Asia Pacific and Europe will stay almost unchanged and other regions will double their share.

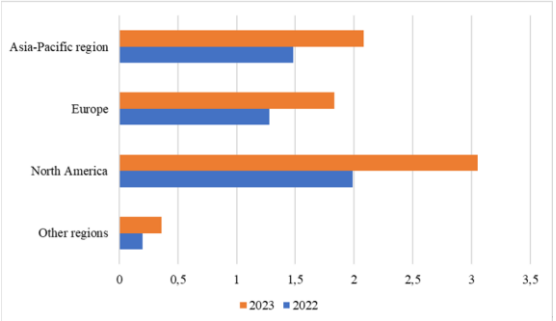

Fig. 4: Segmentation of the bioengineering analytics market by geographical regions in 2022-2023, USD bn

Source: developed by the authors based on Gotadki (2024).

According to these data, the bioengineering analytics market was valued at USD 5.8 bn in 2022 and is forecast to grow to USD 7.4 bn, with a compound annual growth rate of 3.4% between 2023 and 2030. It should be added that the analytics market has grown substantially in recent years. According to forecasts for 2024, its value is expected to increase from USD 26.2 bn to USD 29.2 bn, with an average annual growth rate of 11.5% (Gotadki, 2024). This growth is driven by active sales and marketing of pharmaceuticals, optimisation of healthcare costs, development of biopharmaceutical production, and introduction of digital technologies in the healthcare sector. The market is expected to reach USD 48.4 bn by 2028.

The primary driving forces of the bioengineering analytics market include the growing amount of biomedical data that needs to be processed, the introduction of innovative technologies such as AI and ML, and the continuous development of personalised medicine, which is becoming increasingly popular due to its effectiveness in treating individual diseases (Bisenovna et al., 2024; Berestovenko, 2024). Trends in the market include the integration of predictive analytics into clinical trials, increased focus on data security, and growing demand for Big Data visualisation and processing tools. For instance, personalised medicine uses analytical technologies to tailor treatment to individual genetic characteristics of patients.

Despite the positive trends, there are constraints, including the extensive cost of implementing advanced analytics solutions, which may limit access to them for small and medium-sized enterprises. Furthermore, emerging economies face financial difficulties in implementing modern solutions due to the high cost of analytical equipment and software. The dynamics of the bioengineering analytics market itself is shaped by both development drivers and constraints (Table 1).

Thus, the analysis of the global bioengineering analytics market confirmed the continuation of the growth trends observed in previous years. Forecasts suggest that the bioengineering analytics market will continue to grow rapidly due to key factors. Specifically, the growing need for innovation, driven by the high rate of research in the biotechnology and medical device industries, is driving demand for analytical tools that support the development of new products. Technological improvements, such as advances in AI and ML, are opening new opportunities for more sophisticated analytical platforms (Khan et al., 2025; Leonow et al., 2019). This enables deeper data analysis and

more accurate forecasts. Furthermore, the growing volume of data generated from various sources, such as clinical trials, research, and commercial activities, is forcing companies to implement new analytical solutions to process and analyse it.
The focus on regulatory requirements is also increasing the demand for analytical solutions that ensure product compliance with regulatory standards. Furthermore, global expansion, including expansion into new markets in the Asia Pacific, where investments in healthcare and bioengineering are on the rise, will further boost the analytics market. In conclusion, the global bioengineering analytics market has and will continue to show exciting potential for growth and innovation, especially due to technological advancements and the growing need for efficient data management.

Table 1: Drivers, trends, and restraints of the bioengineering analytics market

Category	Drivers	Trends	Restraints
Technological development	Increased use of AI and ML technologies	Integrating predictive analytics into the drug development process	Excessive cost of implementing analytics solutions
Personalised healthcare	Tailoring treatment to the individual needs of patients	Development of technologies for analysing genomics and molecular data	Inaccessibility of modern technologies for small companies
Regulatory environment	Increased data security and regulatory compliance requirements	The use of blockchain to ensure data transparency	Challenges with regulatory compliance in various countries
Demand for innovation in healthcare	Growing need for innovative approaches to treating chronic diseases	Data visualisation tools to improve diagnostics	Limited financial resources in developing countries

Source: created by the authors based on Life Science Analytics Global Market Report (2024).

3.2 Analysis of the global bioengineering software market

The global bioengineering software market is experiencing rapid growth, driven by advances in healthcare, pharmaceuticals, and medical devices. With the digitalisation of biotechnology processes, software is becoming a key tool for managing data, optimising research and development, and improving the quality of medical and pharmaceutical services. The growing demand for innovative solutions such as Big Data, AI, and automation is driving investment in bioengineering software, which improves the efficiency and safety of processes, reducing the time to develop new products and therapeutic approaches.
The global integration of analytical tools in the field of bioengineering faces several technological, ethical, and legal constraints. One of the key technical challenges is the lack of unified standards for interaction between software platforms, databases, and analytical modules, which complicates data exchange between institutions and countries. Although international standards, such as ISO/IEC 27001:2022 (Information security certification) and ISO 13485 (medical software), provide a general framework for ensuring compatibility and quality, their implementation is uneven, especially in developing countries and among small companies. Ethical issues center around questions of algorithm transparency, bias in AI-based decision-making, and proper patient information and consent when collecting sensitive biomedical data. Situations where analytical decisions influence clinical diagnosis, therapeutic approaches, or clinical trial results are particularly challenging, requiring a high level of trust in technology.
Legal barriers are primarily related to differences in personal data protection regulations in different jurisdictions. The European General Data Protection Regulation (GDPR) sets strict requirements for the processing of medical information, including the need to obtain explicit consent and comply with the principle of data minimization. In the US, the Health Insurance Portability and Accountability Act of 1996 (HIPAA) (2024) regulates the use and transfer of medical information. These legal regimes have limited mutual compatibility, which creates challenges for international projects. Additional complexity is added by national data localization laws in China, India, and a number of other countries that restrict the cross-border transfer of biomedical information.
In response to these challenges, several international initiatives aimed at harmonizing standards have been launched. The Global Alliance on Genomics and Health (GA4GH) is developing ethical and technical recommendations for cross-border sharing of genomic data (GA4GH approves two new..., 2025). In addition, the International Organization for Standardization (ISO) continues to develop standards for AI management in bioengineering, regarding trust in analytical systems (ISO/IEC TR 24028:2020) (Information technology – Artificial..., 2020).
In the context of the bioengineering software market, global crises, such as pandemics (e.g., COVID-19) and economic downturns, have a dual impact, manifesting in both short-term disruptions and long-term structural changes. On the one hand, economic downturns often lead to reduced investment in high-tech solutions, slower adoption of new software platforms, and a rethinking of companies' strategic priorities. During such periods, small and medium-sized enterprises may abandon expensive analytical solutions due to limited access to financing, which temporarily restrains market expansion.
On the other hand, pandemics, as the example of COVID-19 has shown, often stimulate digitalization and innovation, particularly in healthcare and biomedical research. The pandemic has been a catalyst for the adoption of cloud solutions, remote patient monitoring software, clinical trial automation, and the development of epidemiological analysis software (Yu & Xiao, 2023; Vychuzhanin & Vychuzhanin, 2025). In response to the emergency, the market demonstrated flexibility and the ability to quickly adapt to new challenges, leading to long-term growth in demand for bioengineering IT products. Although economic instability may slow the pace of innovation in some sectors, crises often catalyze transformation, especially in areas related to healthcare, security, and scientific research.
Bioengineering software includes tools for research and management in biology, anatomy, healthcare, and pharmaceuticals (Skidan et al., 2023; Ahmadov, 2024). It helps to standardise workflows and manage documents in biopharmaceuticals, medical technology, and clinical care. The key purposes of using the software include improving product quality, regulatory compliance, and productivity in clinical trials and medical device innovation (Rexhepi et al., 2023; Dostanova et al., 2024). Such applications enable secure recording and storage of data, accelerating access to it for healthcare professionals.
Overall, such software is experiencing rapid development in 2020 due to the integration of advanced technologies. In 2024, the focus is on improving tools for genomics, modelling biological processes, and optimising clinical trials. Specifically, the software helps automate laboratory processes, reduce drug development time, and ensure the accuracy of medical prognoses. In 2022, the global bioengineering software market was worth USD 16.32 bn, and is expected to increase to USD 44.72 bn by 2030, with a projected annual growth rate of 12.9% (Life Science Software Market, 2023). The bioengineering software market is also projected to grow at a faster pace, showing a compound annual growth rate of 7.5% in 2023-2032, compared to 6.4% in 2018-2022 (Global Life Science Software…, 2023). This growth is driven by the growing demand for software, which is contributing to an increase in market value from USD 13.74 bn in 2023 to USD 31.15 bn in 2033. It is also forecast to grow by 7.9% in 2023-2028 (Global Life Sciences…, 2024). By 2033, the global market is

expected to reach approximately USD 40.4 bn, up from USD 14.9 bn in 2023, showing a compound annual growth rate of 10.5% between 2024 and 2033 (Fig. 5).

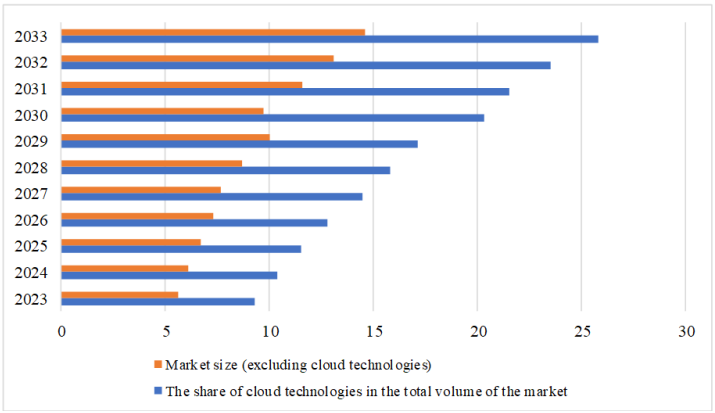

Fig. 5: Global bioengineering software market size and share of cloud technologies in 2023-2033, USD bn

Source: developed by the authors based on the Global Life Sciences Software Market (2024).

In other words, cloud technologies are taking an increasing share of the global bioengineering software market. In 2023, their share was USD 9.3 bn, and by 2033, it is expected to grow to USD 25.8 bn. This indicates a steady increase in demand for cloud solutions, which are becoming an integral part of the market. The total non-cloud market is also growing, but at a slightly slower pace: from USD 5.6 bn in 2023 to USD 14.6 bn in 2033. This underlines the significance of cloud platforms in the development of the bioengineering software market, as their implementation ensures efficiency, scalability, and accessibility of solutions for life science research and clinical trials.

However, the bioengineering software sector is facing major changes in private funding and investment. For instance, in 2023, USD 20.5 bn was invested in 462 deals, which is 44% less than in 2022 (Global Life Sciences…, 2024). Although investment volumes declined, the number of deals stayed stable, indicating continued interest in the sector despite a decline in valuations and deal sizes. In 2022, there was also active funding for bioengineering software start-ups, with investments reaching USD 5.3 bn in 260 deals. Investors demonstrated strong confidence in the sector's potential, supporting large innovative projects. Overall, investments in life sciences software companies reached USD 36.8 bn in 786 deals.

Growth trends in the bioengineering software market can be observed not only on a global scale but also at the level of individual countries. In various regions of the world, growth rates vary depending on investments in research, innovation, and integration of technologies in the healthcare sector (Table 2).

Table 2: Forecast of the bioengineering software market development in various countries until 2033

Country	Average annual growth rate	Key growth drivers until 2033
India	10.3%	Increased spending on healthcare research, implementation of innovative software solutions
United Kingdom	6.1%	Integration of technologies to improve research and innovation in the life sciences
China	8.3%	Development of the biotechnology and pharmaceutical sectors using software
Australia	2.7%	Use of software to improve research and development processes in the life sciences
Japan	6.4%	Technological expertise and focus on software applications in research and healthcare

Source: created by the authors based on Global Life Science Software Market – Industry Trends and Forecast to 2030 (2023).

Thus, the highest growth rates in the bioengineering software market are expected in India and China, due to active investment in research and development in the healthcare and biotechnology sectors. The UK and Japan are also showing steady growth, focusing on innovation and integration of software solutions into medical research. In Australia, however, market growth is slower, suggesting a gradual development of the sector.

Notably, other countries, such as the US and Germany, are also expected to experience steady growth due to strong innovation ecosystems and high demand for medical research software. For instance, in the US, the development of bioengineering technologies is supported by major investments from both the government and the private sector, which is driving the growth of this market. On the other hand, in Ukraine, the bioengineering software market is still in its infancy, and its growth could potentially accelerate due to the introduction of modern technologies in the healthcare, pharmaceutical, and biotechnology sectors. The key factors that may contribute to growth are investments in innovative solutions, modernisation of medical infrastructure, support for start-ups in the biotechnology sector, and integration of cloud technologies for life science research and clinical trials.

According to the segmentation of the software market in 2023, North America is the leading country with a 31.3% share of revenue (Fig. 6) (Global Life Sciences Software…, 2024). This significance is conditioned by the strong pharmaceutical and biotechnology sectors, as well as the emphasis on research and development. Increased adoption of advanced technologies and significant investments are driving market growth in the region. Key drivers include increased research, integration of cloud-based solutions, and the use of software in healthcare companies' business operations, particularly for analysing clinical trial data through the SAS database, which is essential for early medication development and predicting healthcare outcomes.

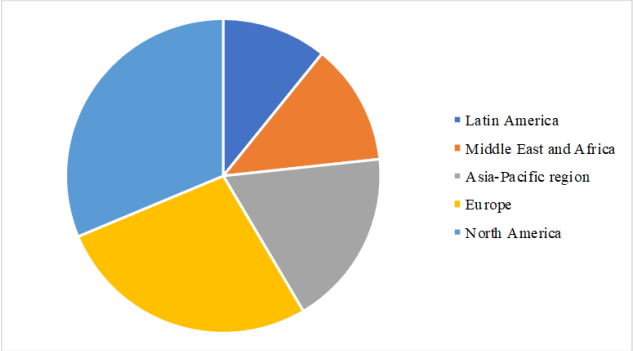

Fig. 6: Segmentation of the global bioengineering software market by geographical regions in 2023, %

Source: developed by the authors based on the Global Life Sciences Software Market (2024).

Based on this segmentation of the global bioengineering software market, North America is the leading region, highlighting the significance of this region for the development of bioengineering software, specifically due to its strong pharmaceutical sector and active adoption of advanced technologies. Europe is ranked second, which also suggests its major role in research and biotechnology innovation. Asia Pacific is showing rapid growth, driven by investments in the pharmaceutical sector and bioengineering innovations. The Middle East and Africa, together with Latin America, have relatively smaller shares, but their market are also showing development, particularly due to the introduction of innovative technologies and support from international investors.

In 2023, the demand for bioengineering software in North America was estimated at USD 5.7 bn, and it is expected to grow significantly in the future (Global Life Sciences Software…, 2024). The US, as a key player in the region, is home to leading life sciences companies that implement advanced technologies in medicine development, clinical trials, and healthcare. Regulators are actively supporting digital solutions that improve healthcare efficiency, and a developed IT infrastructure facilitates their integration. The Asia-Pacific region is expected to see rapid market growth due to active research and development activities and investments in medical infrastructure. From 2008 to 2021, the region attracted major investments, specifically in pharmaceuticals (USD 36 bn), medical equipment (USD 20 bn), biotechnology (USD 17 bn), and healthcare (USD 10.8 bn), which suggests a strong level of investor interest in these sectors. Europe is also a vital market for bioengineering software, supported by high public and private investment in research. Countries such as Germany, the UK, and Switzerland are actively using software to optimise research and improve medical outcomes, driving demand for secure digital solutions.

The global life sciences software market (2024) is expected to reach USD 17.7 bn in 2026, growing from USD 15.9 bn in 2021 at a compound annual growth rate of 2.2%. In 2021, IQVIA was the leader, followed by Microsoft, Veeva Systems, Salesforce, and Dassault Systèmes. The top five companies with the fastest growth rates in 2021 were Veeva Systems, IQVIA, PerkinElmer Informatics, Salesforce, and Dassault Systèmes (Fig. 7). For their part, customers are increasingly investing in new features and capabilities to replace legacy systems, driving competitive upgrades and replacements that could affect market distribution in the future.

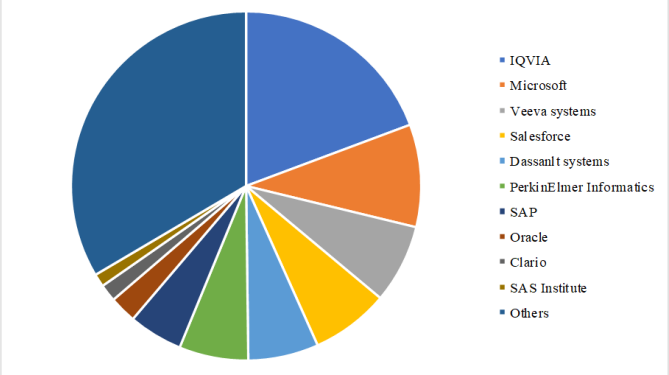

Fig. 7: Segmentation of the bioengineering software market by vendor in 2021, %

Source: developed by the authors based on Pang et al. (2024).

Thus, in 2021, the bioengineering software market was dominated by several large players, which accounted for most of the sales. The leader was IQVIA, which was well ahead of Microsoft and Veeva Systems. Other notable players were Salesforce and Dassault Systèmes. Overall, the top ten companies controlled 66.5% of the market, while the remaining vendors shared 33.5%. This indicates a highly concentrated market, with several large companies holding leading positions, but with room for smaller players with specialised solutions.

Furthermore, the bioengineering software market continues to show growth trends, largely due to technological advances and increased demand for innovative solutions (Table 3). Specifically, the use of AI and ML opens new prospects for optimising R&D processes. However, the market also faces certain constraints, including the excessive costs of implementing advanced solutions and the limited availability of modern technologies for small and medium-sized companies.

In other words, the bioengineering software market continues to evolve under the influence of both positive factors and constraints. Technological advances, such as the development of AI and ML, are driving market growth, contributing to the creation of new tools for research and personalised treatment. At the same time, there are major barriers, including the excessive cost of implementing advanced technologies, the complexity of regulatory compliance, and limited opportunities for small and medium-sized enterprises.

Thus, the analysis of the global bioengineering software market shows a steady increase in demand for innovative solutions, driven by the rapid development of medical technologies and the growing number of research projects in the field of biomedical sciences. Technological

advances, specifically the introduction of modern technologies, are becoming key factors in optimising bioengineering processes, accelerating the development of new medicines, and improving medical services.

Table 3: Drivers, trends, and restraints of the bioengineering software market

Category	Drivers	Trends	Restraints
Technological development	Advances in AI and ML technologies	Integration of AI into research and development processes	Excessive cost of technology implementation
Precision medicine	Growing demand for personalised treatment	Use of genomic and molecular data for diagnostics	Inaccessibility of advanced solutions for small companies
Regulatory environment	Government support for healthcare innovation	Implementation of data security and cybersecurity standards	Complexity of regulatory compliance
Growing volume of data	Increased volume of medical and genomic data	Development of Big Data analytics platforms	Lack of qualified specialists
Investments in research	Increased public and private investment	Development of tools to support medical research	Limited financial resources to implement new solutions

Source: developed by the authors based on Bioengineering Technology Market: Evaluation of the Modern Healthcare System to Drive the Market (2024).

4. Discussion

To substantiate the findings, it is useful to consider analogous studies that highlight the effects of digital technologies on medical data management in the field of bioengineering. For instance, Sheikhbahei & Ari (2024) showed that digital technologies such as AI, Internet of Things (IoT), and blockchain can optimise resource management and increase efficiency, including healthcare opportunities through improved transparency and forecasting. The current study added to this by demonstrating that specialised analytical tools and bioengineering software with predictive analytics play a crucial role in improving the quality of healthcare services and accelerating healthcare innovation by enabling deeper integration into healthcare and economic processes. Wiggin et al. (2024) also focused on the use of software in medicine aimed at automating and improving the accuracy of analysis. The difference is that Wiggin et al. developed a tool for analysing cell dynamics in tumour models, while the current study covered the bioengineering analytical software market, focusing on predictive analytics and its role in improving bioengineering processes.

While Mestrallet's (2021) study focused on specific software for the treatment of burns, the current study covered a wider range of applications of analytical tools in medicine, which highlighted its potential to improve the quality of medical services and healthcare innovation. While the present study analysed the market for analytics and software in bioengineering, emphasising the significance of analytical tools, Lam et al. (2021) focused on the integration of interdisciplinary concepts in bioengineering curricula, which may limit the practical application of analytical tools in real-life medical situations. The current study not only analysed the market but also proposed concrete solutions for the implementation of analytics, which can greatly improve the quality of medical services and provide more effective strategies for bioengineering.

Filipovic (2020) focused on computational methods and disease modelling, emphasising the technical aspects of bioengineering, while the current study analysed the global bioengineering market, focusing on economic trends and the effects of technology on healthcare services. The present study offered a broader context for understanding market dynamics and their effects on the adoption of the latest technologies in medical practice. Pasupuleti (2024) focused on the revolutionary advances in bioengineering that considerably influence healthcare and agriculture. While the study emphasised technological innovation and ethical aspects, the current study examined the global bioengineering analytics and software market, showing how specialised analytical tools can improve the efficiency of healthcare services, which is an essential factor in the medical and economic spheres.

Yu et al. (2024) focused on the technical aspects of creating nanostructures for therapeutic applications and diagnostics, which can greatly contribute to the accuracy of medical interventions. The current study complements this study with a broader analysis of the bioengineering analytics and software market, covering economic aspects that provide insight into the role of such innovations in the global healthcare system and their effects on healthcare data management. In addition, Boulaaras & Pham (2024) demonstrated the use of mathematical modelling to solve complex problems in bioengineering, emphasising the role of quantitative approaches for a deeper understanding of biological systems. The current study, in contrast, covered the analytical and market aspects of bioengineering analytics and software, showing not only the value of forecasting models, but also the economic effects of innovations on medical processes, complementing the other study with a view on the market and practical implementation of such methods.

Eskandar (2023) provided an overview of modern innovations in biotechnology, including advances in Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR), bioinformatics, synthetic biology, and nanotechnology. The current study complemented these aspects by focusing on the analysis of the global bioengineering software and analytics market, emphasising the economic effects of the introduction of analytical technologies in healthcare services, which extended the perspective offered in the cited study by assessing the effects of these innovations at the market level. Bošković et al. (2024) focused on advances in synthetic biology and metabolic bioengineering, specifically the potential of systems approaches to optimise the production of bioeconomically significant substances. In contrast, the current study, apart from assessing technological impact, identified key trends and prospects for healthcare and economic processes related to bioengineering innovations, and offered an analysis of prospects based on regional market trends.

Gan et al (2023) focused on the technical parameters of bioreactors in bioengineering, while the present study provided a comprehensive analysis of the bioengineering analytics and software market, covering the medical and economic trends and prospects for the industry. Whereas Nwokoye & Abilez (2024) examined bioengineering strategies for organoid vascularisation, the current study examined analytical trends in bioengineering, which highlighted the significance of data tools for optimising such bioengineering processes. On the other hand, Niroomand et al (2024) studied bioengineering technologies for organ transplantation that improve the quality of donor organs and solve problems with their availability. The current study complemented this research by focusing on analytics and software that can optimise bioengineering processes, particularly in the context of transplantation.

Reddy et al. (2024) emphasised the role of integrating bioengineering and data analytics in healthcare, focusing on current innovations and challenges. The present study complements this study by offering a detailed analysis of bioengineering software and analytics, particularly in the context of optimising medical processes and increasing the effectiveness of personalised medicine. Since the present study offered an analysis of trends and prospects for the global bioengineering market, emphasising the effects on medical and economic processes and practical solutions for improving healthcare systems, it is more specific than the study by Dhivya et al. (2023). The latter study considered the application of AI in bioengineering and its subdivisions, focusing on a wide range of technologies. Salhab (2024) presented data analytics in digital marketing, focusing on its effects on competitiveness and business process optimisation. The current study extended this

research by providing an in-depth analysis of the global bioengineering market, demonstrating the considerable growth potential and significance of implementing analytical tools to improve marketing strategies in the medical field.

Dudaryeva et al. (2023) investigated the mechanical memory of cells, which affects the results of bioengineering applications, specifically in stem cell therapy. In contrast, the current study not only analysed the challenges of bioengineering but also provided a detailed overview of global market trends in analytics and software, highlighting their potential to improve medical and marketing strategies in this area. While Sabriuly et al. (2023) reviewed innovative approaches to bioengineering neural systems, focusing on 3D bioprinting and the use of biomaterials for the treatment of neurological disorders, the current study analysed market trends in bioengineering. In other words, the present study highlighted the significance of analytics and software in bioengineering, which allows for identifying key growth factors and developing effective marketing strategies.

While Wanika et al. (2024) considered the significance of structural and practical identity analysis in bioengineering process modelling, emphasising its role in the reliability of parametric estimates, the current study focused on market trends and the use of analytics in bioengineering. This study highlighted the role of analytical approaches to optimise marketing strategies and identify key factors influencing the development of life science processes. Finally, Soares et al. (2023) discussed the application of systems bioengineering to investigate the effects of toxic agents on developing organisms, emphasising the role of an integrated approach to analysing interactions between various biological systems, while the present study focused on market trends and analytics in bioengineering. Thus, the present study revealed the role of analytical methods in formulating effective marketing strategies and identifying key factors that influence bioengineering processes in this area.

Thus, the findings of the present analysis confirmed that the bioengineering analytics and software market is experiencing high growth rates due to innovations that can greatly improve medical and economic processes, affecting the quality of medical services and the efficiency of data management. The findings highlighted the need for new analytical solutions to help adapt to the rapidly changing healthcare environment and facilitate the further development of bioengineering.

5. Conclusion

The findings of this study revealed key trends and growth forecasts for the global bioengineering analytics and software market. In 2022, the analytics market was worth USD 9 bn, with the potential to reach USD 16.3 bn by 2030, representing a compound annual growth rate of 7.6%. This growth indicates a growing interest in analytics solutions in the healthcare sector, which can substantially improve the efficiency of data management and the quality of healthcare services. The study also found that the services segment accounted for 54.8% of total market revenue, suggesting the active adoption of outsourcing practices in the analytics industry. This segment dominated in 2022 due to the growth of outsourcing, accounting for 57.1% of revenue. The highest growth in the analytics segment is expected in predictive analytics (9% per year) and research and development (9.8%). The on-demand services segment also showed rapid growth due to the development of cloud solutions and remote access. This creates new opportunities for adapting analytical technologies to the changing needs of healthcare facilities.

Notably, the global bioengineering software market was worth USD 16.32 bn in 2022, with a forecast to grow to USD 44.72 bn by 2030 at a compound annual growth rate of 12.9%. Growing demand for software solutions that improve market value, along with active investment in start-ups in this area, confirmed the trend towards stable development of the life sciences and clinical trials software market. It was also found that cloud computing, which was valued at USD 9.3 bn in 2023, could grow to USD 25.8 bn by 2033, suggesting the significance of investing in infrastructure.

Limitations of the study included the lack of data on specific regional markets, which may show varying development trends. It is crucial to consider that the culture and economy of each country can substantially affect the effectiveness of analytical solutions. This underscores the need for further research aimed at better understanding the effects of these factors on technology adoption in various regions. Furthermore, the limited timeframe of the study may result in not all market trends being adequately reflected, as they can change in a brief time, requiring regular data updates and analysis. In addition, insufficient attention to changes in the legislative and political environment may substantially affect the accuracy of forecasts and recommendations, which requires further research to factor these aspects in.

In the future, it is recommended to focus on the development of new analytical platforms that integrate modern technologies, including artificial intelligence and machine learning. This can contribute to more efficient data management, process optimisation, and improved quality of healthcare services. Research into external factors, such as legislative changes, technological advances, and changes in consumer behaviour, may also be significant areas for further analysis, providing a more comprehensive view of the development of the bioengineering analytics and software market.

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