REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ISSUES OF ASSESSMENT OF THE APPLICATION AND ECONOMIC EFFICIENCY OF INNOVATIONS IN THE FIELD OF PETROLEUM MACHINERY

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Applicant:	**Sharifli Ismail Elman**

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The dissertation was completed at Odlar Yurdu University.

Scientific supervisor: Doctor of Economic Sciences, Professor
Aliyev Tarbiz Nasib

Official opponents: Doctor of Economic Sciences, professor,
Hajizade Elshan Mahmud

PhD in economic sciences, associate professor
Jabbarov Ayatulla Suvahil

PhD in economic sciences, associate professor
Hajiyev Galib Bahram

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Doctor of Economic Sciences, Professor, Honored Agricultural Worker,
Ibrahimov Islam Haji

GENERAL CHARACTERISTICS OF THE RESEARCH

The Relevance of the Topic and Degree of Exploration. The globalized world economy, due to the development of the international division of labor, has created conditions for the expansion of economic relations between different countries, creating broad conditions for the application of innovative technologies in increasing the competitiveness of the products produced by enterprises in the world market. The mutual integration of the socio-economic systems of different countries of the world has created broad opportunities for the transition to innovative development. The innovative type of development predetermines the unity of scientific, technical and production areas and, on the basis of such interaction, increases the competitiveness of the technologies used, the products produced, the services provided, etc.

The "Strategic Roadmap for the National Economy of the Republic of Azerbaijan" and the "Strategic Roadmap for the Development of Heavy Industry and Mechanical Engineering in the Republic of Azerbaijan" approved by the Decree of the President of the Republic of Azerbaijan dated December 6, 2016 indicate that the material base and traditions of this industry have been preserved, the technical skills of the staff have been improved, the raw material base of the industry exists, the industry is provided with state support, and general infrastructure and concessions for business activities are implemented..[1]

In the Decree on Approval of "Azerbaijan 2030: National Priorities for Socio-Economic Development", signed by the President of the Republic of Azerbaijan Ilham Aliyev on February 2, 2021, one of the issues envisaged in the implementation of the 5 main National Priorities for the socio-economic development of the country is the creation of a modern innovation space.[2] In such a space, the focus is

[1] Strategic Roadmap for the Development of Heavy Industry and Mechanical Engineering in the Republic of Azerbaijan". Baku, December 6, 2016.

[2] "Azerbaijan 2030: National Priorities for Socio-Economic Development", signed by the President of the Republic of Azerbaijan Ilham Aliyev, Baku, February 2, 2021 No. 2469..

on the production of machinery and equipment for the oil and gas industry by applying progressive innovations in the non-oil industrial sector and sending them to foreign markets as well as the domestic market, and increasing their efficiency.

The study shows that from the point of view of selecting innovation sources and increasing production capacities, the boundaries of innovation should be determined by the value zone between 2-10% of the value of the country's main production funds. If the innovation in the value of the production fund is up to 2% and the improvement is above 10%, this is already considered creative innovative development. The most important link in innovative development is technical rearmament, aimed at replacing low-yield, outdated equipment with new, more productive ones. Equipping production facilities with more productive equipment in accordance with the content of creative, innovative development makes the innovative development of the machine-building industry a priority.

Since the machine-building industry is the most important sector that ensures the innovative development of enterprises operating in various sectors of the economy, this sector is of great importance for the innovative development of the oil industry, which is an important subsector of the Azerbaijani industry. Innovations in the oil machine-building industry, including the introduction of oil and gas and geological exploration equipment that meet world standards, nano technologies, and the renewal of fixed assets depend on the level of development of oil machine-building enterprises. Along with the introduction of innovations and increasing the efficiency of oil machine-building enterprises, it is of urgent importance to increase the export potential of modern and progressive machines and equipment produced.

In ensuring the sustainable socio-economic development of our country, the innovative activity of industrial enterprises producing export-oriented machines and equipment, including oil machines and equipment, is closely related to the organization of optimal management of innovation processes in accordance with modern requirements and constant improvement in order to increase its economic efficiency.

The purpose of implementing innovations and increasing the efficiency of oil machinery enterprises is to meet the current and future requirements of national oil production and processing, to strengthen their export-oriented ability to compete in the international machinery and equipment market. The reality that the demand for innovative machinery and equipment required for oil and gas production and processing in countries specializing in oil and gas production and export and having rich oil and gas reserves will increase even more in the future, and the ability of the oil machinery industry in Azerbaijan to produce and export machinery and equipment, shows that the chosen dissertation topic is relevant and has significant theoretical and practical significance.

The perspective development directions of the country, which uses innovation activity and the results of innovative processes in economic and social life in machine-building enterprises, have proven themselves. Considering that Azerbaijan is the first country in the world to produce oil industrially and thus has a strong economic and intellectual potential and management system for the production of export-oriented oil machinery and equipment, our country can have a positive impact on ensuring the production of innovative, competitive and science-intensive products for export. For this purpose, the study of the innovation activities of oil machinery enterprises operating in Azerbaijan and the preparation of proposals once again increase the relevance of the topic.

The level of innovation activity of the country and the significant role of innovations in determining the competitiveness of processing industry enterprises in general, especially machinery and equipment manufacturing enterprises, as well as the issues related to the application of innovations and directions of their improvement in oil machinery manufacturing enterprises producing export-oriented products, have been studied in the works of economists of the Republic of Azerbaijan Z.A. Samadzade, A.A. Nadirov, A.F. Musayev, T.N. Aliyev, M.J. Atakishiyev, G.A. Safarov, E.M. Hajizade, I.A. Aslanzade, G.A. Azizova, A.H. Taghiyev, F.H. Gasimov, A.G. Huseynova, S.H. Abbasova, G.S. Suleymanov and others, who have made a great contribution to the development of the

national economy.

One of the economists of our republic, professor Tarbiz Aliyev, in his research “Clusters: International Experience and Innovative Development”, attached great importance to innovative development and noted the existence of a connection between the country's innovative development and cluster development. In this research, unlike other researchers, when defining the concept of a cluster, he emphasized that a cluster is an innovation infrastructure.

Researchers I.T. Balabanov, F.G. Gabibov, R.A. Fatkhutdinov, L.P. Goncharenko, L.G. Sitkina, A.A. Shamrai, T.A. Fedoseeva, V.N. Kolchikhina and others played a major role in investigating the problems of innovation activity of enterprises, as well as the application of innovations in the field of oil engineering and its economic efficiency. In their researches, the authors explained the theoretical and methodological principles of innovation, widely emphasized its connection with socio-economic and market requirements, and conducted various studies of practical importance on the connection of innovation with economic activity. The research work conducted by these authors has played a positive role in the connection of innovation with the processing industry, including the production of machinery and equipment. However, the potential opportunities for producing competitive machinery and equipment, especially for the oil and gas industry, and introducing them to the international machinery and equipment market through the application of progressive innovations have not been sufficiently reflected in these research works.

The object of the study was selected as innovative oil machinery enterprises that produce export-oriented machinery and equipment for the oil machinery industry.

The subject of the research is the system of economic relations related to the application and economic efficiency of export-oriented innovations in the production of machinery and equipment at oil engineering enterprises.

The Purpose and Objectives of the Research. The purpose of the research work is to investigate the theoretical and methodological foundations of innovation activity in Azerbaijan's oil machinery

enterprises in modern conditions, analyze the current state of innovation implementation, assess the innovative activity management and innovative development potential in export-oriented oil machinery and machinery enterprises that produce them, and develop proposals for the implementation of innovations in the field of oil machinery and increasing economic efficiency.

In order to achieve the stated purpose, it is essential to accomplish the following research objectives:

- research on the theoretical foundations of organizing innovation activities in oil machinery enterprises producing export-oriented products;
- determining the characteristics of the organizational and economic mechanism for the application of innovations in the production of machinery and equipment;
- study of the methodological foundations of the formation of an organizational-functional mechanism of innovation and investment activity in oil machinery enterprises producing export-oriented machinery and equipment;
- comprehensive analysis of the current situation of oil machinery manufacturing enterprises in Azerbaijan that produce innovative machinery and equipment;
- analysis and assessment of the innovation potential of export-oriented machinery and equipment production at oil machinery enterprises;
- calculation of the efficiency of new innovations to be introduced in the field of petroleum engineering;
- determining the export potential of export-oriented innovative petroleum machinery enterprises for the independent development of the petroleum machinery industry;
- determination of directions for creating optimal relationships between innovation costs and production volumes in mechanical engineering enterprises;
- to evaluate the effectiveness of state support mechanisms for oil machinery enterprises and propose new incentive mechanisms;
- development of proposals and recommendations regarding the

economic efficiency of export orientation through the application of innovations in the field of oil and gas machinery and equipment production in Azerbaijan.

Research methods. In the implementation of the research work, analytical, data observation, collection, comparison, analysis-synthesis, econometric modeling on Eviews-12 application software packages, systematic analysis, scientific abstraction, graphic and other economic-statistical methods were used. The methodological basis of the research work consists of scientific-research works of economists on the application of innovations in the field of oil engineering, increasing its efficiency, organizational-economic mechanisms of production of export-oriented machinery and equipment. In connection with its implementation, references were made to the provisions of relevant laws, decisions of the Cabinet of Ministers, materials of the State Statistical Committee, materials of the "Strategic Road Map" on the development of heavy industry and mechanical engineering in the Republic of Azerbaijan and other socio-economic development programs were used.

The Main Provisions Submitted for Defense:

1. In order to ensure the competitiveness of machinery and equipment manufactured by the oil engineering enterprise in the world market, it is necessary to base the production process on innovation and determine the theoretical and methodological foundations of the characteristics of production functions related to the implementation of innovative activities.

2. There is a need to determine the methodological foundations for the formation of an organizational-functional mechanism for the interaction of innovation and investment activities in oil engineering enterprises that produce machinery and equipment;

3. Since oil machinery manufacturing enterprises based on the application of innovative technologies and producing machinery and equipment have different levels of management mechanisms, there is a greater need for state support, which necessitates the development of cooperative relations here;

4. It would be useful to develop a methodology for determining economic indicators of production, management, and economic and

financial activities of oil machinery enterprises that produce export-oriented machinery and equipment based on the application of innovative technologies;

5. Implementation of innovation projects for the production of machinery and equipment in the field of petroleum engineering, and the discovery of innovation potential for the development and adoption of new products that are competitive in foreign and domestic markets can have a positive impact on the development of the field;

6. It would be useful to develop a methodology for measuring economic performance indicators of enterprises producing innovative products in the field of petroleum engineering and to adapt them to the requirements of the state's cooperative support mechanism;

7. There is a mutual relationship between the cost, income, profitability and other economic indicators of newly applied innovations for the production of export-oriented competitive machinery and equipment in the petroleum engineering industry and the improvement of the efficiency of projects and scientific research works to be prepared for the prospective period;

Scientific novelty of the research. The research analyzed and evaluated the issues of application of innovations and economic efficiency in oil machinery manufacturing enterprises of the Republic of Azerbaijan that produce export-oriented machinery and equipment, and the following main scientific innovations were obtained:

- According to the calculations carried out in the research, the potential opportunities for increasing the competitiveness of export-oriented machinery and equipment produced in the field of oil engineering in foreign markets were substantiated, and a competitive strategy was developed regarding the commissioning of innovative technologies included in the fixed assets of the enterprise;

- A comprehensive methodological approach has been developed to assess innovation activity in the oil machinery industry in Azerbaijan;

- A development model has been developed within the framework of an international competitiveness strategy through the application of innovative technologies in oil machinery manufacturing enterprises;

- The development potential of export-oriented machinery and equipment production in the field of petroleum engineering based on innovative technologies has been assessed and it has been determined that this field needs special economic support from the state to be internationally competitive;

- New structural mechanisms have been developed for the application of technological innovations for the production of products that meet international standards at oil machinery enterprises;

- as a result of research, it was determined that the application of innovative technologies at machine-building plants of Scientific Research and Design Institutes has led not only to the organization of innovation-oriented production, but more importantly, to the increase in the production of export-oriented and externally competitive machinery and equipment.

Theoretical and practical significance of the research. The theoretical and methodological provisions given in the study will allow expanding scientific knowledge on the application of innovations and assessment of economic efficiency, the application of innovations in the production of export-oriented oil machinery and equipment, understanding the features of the formation of development and management mechanisms in the field, and solving theoretical issues of the effective use of existing production and export potential and its regulation.

Practical significance of the research – The results and proposals obtained on the basis of assessing the innovation potential of Azerbaijan's oil machinery enterprises can be refined and used in the preparation of targeted programs to strengthen the export orientation of Azerbaijan's oil and gas machinery and equipment.

Research materials can be used in scientific research on the application of innovations in the production of machinery and equipment and economic efficiency, and in teaching subjects related to the preparation and application of innovation projects in the education system.

Approval and application. The main scientific and theoretical provisions of the dissertation, along with its main findings and recommendations, have been reflected in 12 articles (of which 1

article, 1 conference materials are abroad) published in reputable journals and conference materials recommended by the Higher Attestation Commission under the President of the Republic of Azerbaijan. Among the conference materials reflecting the main content of the dissertation, the following theses can be cited: “Main directions of the state's innovation policy in the field of mechanical engineering” (Baku, 2018), “Assessment of innovation potential opportunities in mechanical engineering enterprises” (Baku, 2019), “Ways to activate innovation activity in mechanical engineering enterprises” (Baku, 2020), “Theoretical issues of the restructuring of the mechanical engineering industry” (Baku, 2022), “Assessment of the impact of petroleum engineering on GDP” (Italy, 2022). During the research, the author also published the following articles: “Assessment of factors affecting product production at oil machinery enterprises” (Baku, 2021), “The role of innovation management in the development of the oil and gas sector of Azerbaijan” (Baku, 2022), “The impact of innovation costs on the financial and economic activities of the Baku Workers' Machine-Building Plant Limited Liability Company” (Baku, 2022), “Assessment of the activities of oil machinery enterprises in the Republic of Azerbaijan” (Nakhchivan, 2022), “The influence of innovative costs in machinery construction on tax payments” (Russia, 2022).

Name of the Institution Where the Dissertation Was Conducted. Odlar Yurdu University.

The total volume of the dissertation, with the volume of the structural sections separately indicated, is indicated in characters. The research work consists of an introduction (16680 characters), three chapters (69059 characters for Chapter I, 97152 characters for Chapter II, 77063 characters for Chapter III), conclusion (8525 characters), and 125 sources used, including 160 pages. The dissertation contains 11 tables, 2 graphs, 9 diagrams, and 2 schemes. The total volume of the dissertation is 268479 characters. The dissertation, excluding tables, graphs, diagrams, schemes, and the list of literature, consists of 238566 characters.

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MAIN CONTENT OF THE RESEARCH

The "**Introduction"** of the dissertation outlines the relevance of the topic and degree of exploration, the object and subject of the research, the purpose and objectives of the research, the research methods, the main provisions submitted for defense, the scientific novelty of the study, its theoretical and practical significance, the approval and application, and the volume of the work.

In the first chapter of the dissertation entitled **"Theoretical and methodological basis of innovation activity in the field of machinery"**, the features of the organizational and economic mechanism of introducing innovations in the production of machinery and equipment, the theoretical foundations of innovative activity in the production of machinery and equipment, the features of the formation of a modern management mechanism of innovation activity in the production of machinery and equipment were investigated. It should be noted that the introduction of management innovations of a different nature leads to an increase in the efficiency of the production process. This in turn creates conditions for optimizing business processes in the company, improving product quality and customer satisfaction.

Academician Z.A.Samadzadeh pays special attention to the issues of introducing and financing innovations in the industrial sector. In his works, the provision of financial resources for innovation activity within the framework of the structural transformation of the industry, the application of investment climate and tax incentives are analyzed. The scientist notes that the development of innovation-based financial mechanisms is important for increasing the competitiveness of industrial sectors in the country.[3]

In recent years, the management of innovative organizations has been trying to move from unstructured, non-analytical approaches to the presentation of ideas to a single, structured set of procedures for managing the process of "creating ideas", their development and

[3] Samadzade Z.A. Economy of Azerbaijan in 100 years. In Volume VII. "Letterpress" publishing house. Baku, 2021-2022.

bringing new products to the market. In the largest innovation-oriented corporations, in addition to the classic tools and incentives for management, progressive trends directly related to the innovation process are increasingly distinguished.

Table 1.

The effectiveness of management innovations

Management innovation	Outcome data	Studies
Conducting a strategic audit, developing a strategy and balanced scorecard	Creating a common understanding Strategy enterprises (90%) Improving the quality of strategy implementation (70%) Increasing profits (80%) Improving the quality of planning (90%) Improving budgeting (74%)	Horvath and Associates 2003
Operational business process projects	Improving the efficiency of the core functional process of the business (100%)	Lean Institute (James Womack, Daniel Jones) 2003
Implementation of financial management system	Increasing the level of profitability of the enterprise, reducing capital costs by 1-3%	Neidermans Financial Corporation
Designing efficiency processes of management and organizational structure	Increasing return on capital, competitiveness, revenue, reducing production costs, and increasing customer satisfaction and retention rates	International ISO 10014 standard
Setting the quality of the automation of management	Increases the sales volume of enterprises (61%) Meets the needs of buyers in enterprises (67%) Increases the quality of products in enterprises (78%)	US ETI

Source: prepared by the author based on collected materials.

The application of different management innovations listed in the table increases the profitability of the product produced in the production process, optimizes business processes in the company, and improves product quality, thereby increasing customer satisfaction.

The main features of the formation of a management mechanism for innovation activities in the dissertation are considered to be the following:

1. Systematic and phased approach: A coordinated, flexible management process is required from the generation of the idea to the stages of implementation and commercialization.

2. Institutional and regulatory framework: Management mechanisms should be supported by legislation, fiscal incentives and state strategies.

3. Organizational flexibility: The management structure should be flexible in order to adapt to the changing market and technological environment.

4. Data-based decision-making: Innovation management should be based on data for objective and analytical decision-making.

5. Centralization of human capital: Training and attracting qualified and enterprising personnel should be a priority.

It is noted that the following main criteria can be proposed for all scientific and experimental structures engaged in innovative activities:

1. The scale of the business, which characterizes the volume of the enterprise, its working capital, should be taken into account. The criterion is determined on the basis of data on production capacities, trade turnover, number of employees and other indicators.

2. The level of specific expenses should be specified. The criterion shows the effectiveness of managing the company's existing resources. The indicators for assessing the criterion are how much of the monetary unit of expenditure is spent on income, production of products, etc.

3. The level of progress of the technologies used. This criterion is characterized mainly by indicators related to labor and capital productivity.

4. Image in the capital, securities, sales, labor markets. In this case, the relevant indicators will be market share, capitalization of the enterprise, the value of shares on the stock exchange.

5. Innovation activity. This criterion characterizes the intensity of the application of science to practice and the dynamics of updating

the product range. It can be expressed in terms of the specific weight of new products in the total product range, the percentage of production capacities put into operation, the intensity of product renewal.

6. The efficiency of organizational and economic activity as a whole. This criterion uses indicators of the return on external resources involved, as well as profitability, absolute liquidity ratio, added value, economic value, etc. as key indicators.

Referring to the organizational structure of management prepared by R.A. Fatkhutdinov for the formation of a modern management mechanism for innovative activity, it is noted that the main problems in oil machinery manufacturing enterprises are not related to technological reasons, but to the inefficient use of human and resource potential.[4] Therefore, the research work proposes that the management of innovation activities in oil machinery enterprises should be based on strategic goals affecting all organizational levels and that various types of organizational structures should be considered, taking into account the innovative potential.

In Chapter II of the dissertation entitled **"Analysis and Assessment of the Current Status of the Application of Innovations in the Field of Machinery in Azerbaijan"**, research was conducted on a comprehensive analysis of the application of innovations in the oil machinery industry in Azerbaijan, analysis and assessment of foreign experience in the production of products in the oil machinery industry of Azerbaijan, and analysis and assessment of the potential opportunities for innovations in the oil machinery industry of Azerbaijan.

It is noted that during the Soviet period, up to 70% of the equipment required for oil and gas extraction, drilling and repair of wells was produced in Azerbaijan. At that time, oilfield machinery and equipment manufactured here were exported to 35 countries of the world, and our republic was considered the center of oil machinery manufacturing on an all-Union scale. However, in the first years of independence, as a result of economic difficulties and competition from foreign technologies, most of the local oil

[4] Fatkhutdinov R.A. Innovation management. 6th ed. St. Petersburg, 2011, 420 p.

machinery manufacturing enterprises could not continue their activities, and the sector suffered a sharp decline.

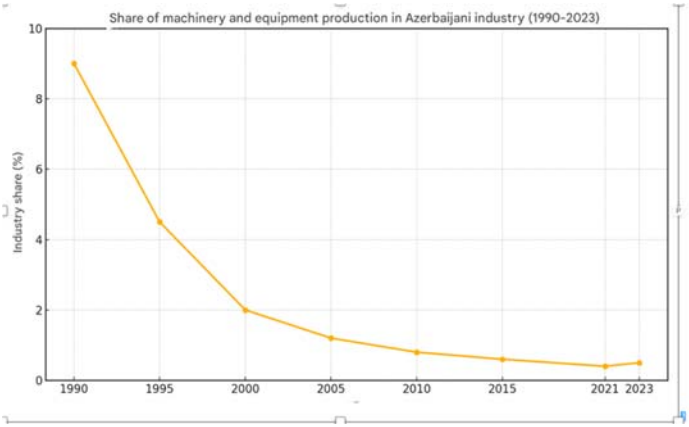

Chart 1. Change in the share of machinery and equipment production in Azerbaijani industry from 1990 to 2023 (%). [5]

Source: *Prepared by the author based on data from the ASSC.*

If we look at the share of machinery and equipment production in Azerbaijani industry, while in 1990 the share of machinery and equipment production in the total value of the country's industrial production was 9%, in 2021–2023 this indicator decreased to only 0.4–0.5%. The reasons for this sharp decline were outdated technologies, lack of investment, and a decrease in demand for local suppliers due to the dominance of foreign companies in the oil sector in the 1990s.

It is noted that this sector, which occupied a leading position in industry in the early 1990s, shrank sharply in subsequent decades and constituted a small part of total industrial production.

Currently, the main organizations producing oil equipment in the country historically consisted of plants and institutes united within the holding called “Azneftkimyamash” OJSC. Of these, Baku Petroleum Machine-Building Plant, Surakhani Machine-Building Plant, Zabrat Machine-Building Plant, Balakhani Machine-Building Plant and

[5] www.azstat.org.

Machine-Building Plant after B.Sardarov are the enterprises with the largest production capacity. Also, scientific and research institutions such as "AzINMASH" - Azerbaijan Scientific Research and Design-Construction Institute of Petroleum Engineering and "Neftmash" Special Design Bureau also serve this sector. It should be noted that until 2017, most of the aforementioned plants belonged to Azneftkimyamash OJSC and operated under state ownership. However, serious institutional changes took place in this area in 2018–2020: in 2018, Baku Petroleum Machine-Building Plant was transformed into an independent legal entity and included in the privatization process, and at the end of 2019, Azneftkimyamash OJSC was liquidated and merged into Balakhani Machine-Building Plant OJSC. As a result, since 2020, oil machinery factories have been directly managed by the State Property Service as separate joint-stock companies and have been gradually privatized. The main goal of these structural reforms has been to modernize enterprises, increase competitiveness, and expand product production by attracting investment and innovation opportunities from the private sector.

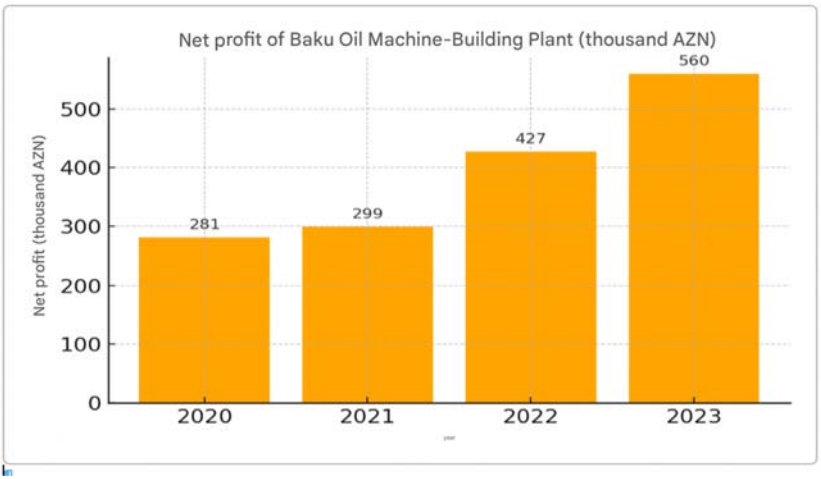

Diagram 1. Dynamics of net profit of Baku Petroleum Machine-Building Plant in 2020–2023

Source: *The diagram was compiled by the author based on materials obtained from the Baku Oil Machine-Building Plant.*

The research study analyzed and evaluated the production volume, net profit, and export indicators of Surakhani Machine-Building Plant and Baku Petroleum Machine-Building Plant operating in the field of oil machinery for the period 2017-2024, and the results were reflected.

If we look at the indicators of Surakhani Machine-Building Plant, although the plant, which operated relatively stably in 2018-2019, faced certain difficulties during the pandemic year (net profit in 2020 was 352 thousand manat), it returned to the path of development from 2021. In 2021, Surakhani's profit amounted to 284 thousand manat, and in 2022 it increased to 376 thousand manat. At the end of 2023, the plant increased its net profit to 440 thousand manat (an annual increase of 17%). According to preliminary data, in 2024 the enterprise earned about 510 thousand manats in profit (+16% compared to 2023) - this figure is the highest indicator in recent years. Diagram 2 shows the profit growth of the Surakhani plant for 2020-2024.

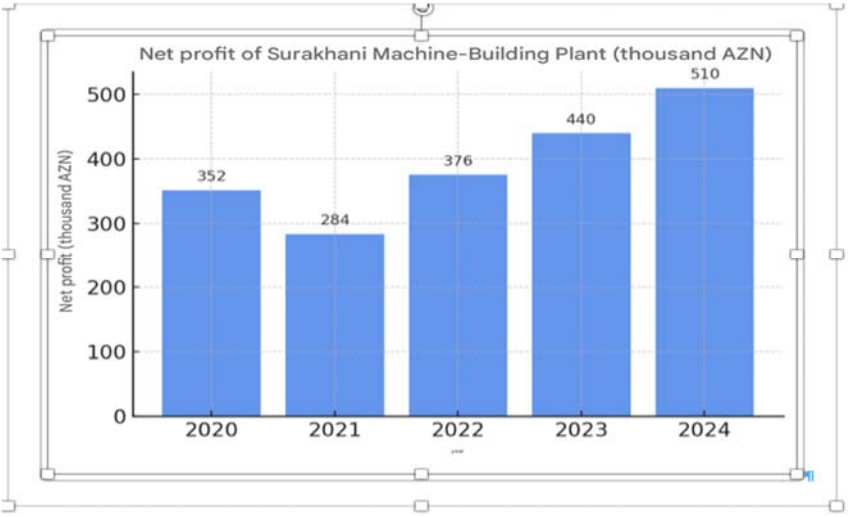

Diagram 2. Growth dynamics of net profit of Surakhani Machine-Building Plant in 2020–2024

Source: *The diagram was compiled by the author based on materials obtained from the Surkhany Machine-Building Plant.*

The study shows that as a result of the rationalization measures taken after 2020, the financial results of the plant have improved, and annual profits have consistently increased. As can be seen, the period 2017–2024 for oil machinery enterprises was gradually replaced by years of recovery and moderate growth. If in 2016–2017 many plants operated with very little profit (or sometimes with a loss), then in 2022–2024 both main plants, both Baku and Surakhani, began to generate net profits measured in hundreds of thousands of manats. This growth is, on the one hand, due to the revival of activity in the oil sector and a certain increase in demand for local equipment within SOCAR, and on the other hand, it is directly related to the structural reforms and modernization measures implemented by the state. As a result of our research, it was determined that new equipment has been provided to enterprises by the State Property Service administration in the last 2 years. As a result of the newly introduced innovations, revival is observed in enterprises.

The Azerbaijani state has aimed to stimulate the application of innovations and scientific research activities in the field of heavy industry and mechanical engineering within the framework of the development strategy of the non-oil sector. The “Strategic Roadmap for the Development of Heavy Industry and Mechanical Engineering in the Republic of Azerbaijan”, approved at the end of 2016, set a number of strategic goals in the sector for 2017–2025. The roadmap set target indicators such as increasing labor productivity by 20% and reducing waste in production by 17%, and it was planned that approximately 20 million manats of investment would be required to implement these measures. This strategic document specifically emphasized that in order to meet the demand in areas such as oil and gas and agriculture, it is important to improve the quality of machinery and equipment produced in the country, introduce new technologies, and strengthen R&D (scientific research and experimental design) activities. It is within this framework that state authorities have begun to implement both legal and regulatory measures - stimulating local production, giving preference to local products in state procurement, etc., as well as direct support tools - preferential loans, grants for innovation projects, tax breaks.

In the research, a SWOT analysis of the sector was conducted in order to assess the current state of the oil machinery industry and specific proposals were made in this direction.

Table 2.

SWOT analysis of the petroleum machinery sector

Strengths	**Weaknesses**
- the existence of an industrial base and traditions; - the technical skills of the staff; - the ability to sell the products to be produced on the market.	- lack of finance, old equipment; - product quality does not meet international standards; - lack of a modern business model in enterprises; - low level of marketing, sales, distribution services; - low level of innovative activities.
Opportunities	**Threats**
- availability of state support for heavy industry and the machine-building sector; - proximity to large regional markets; - availability of general infrastructure for business activities; - availability of incentives for business activities.	- difficulties in accessing foreign financial markets; - the country's lagging behind the processes and new requirements in world industry; - increasing requirements for environmental protection; - strong competition with imported products;

Source: *Prepared by the author based on collected materials.*

Diagram 3 shows the amount of investments in fixed capital in the processing industry, including machinery and equipment manufacturing enterprises, in the Republic of Azerbaijan. As can be seen, the amount of investments, which play an important role in innovation activity, has developed with increasing dynamics in the processing industry, as well as in the production of machinery and equipment. Although a larger part of the investments in the processing industry were financed from domestic sources, all investments in the production of machinery and equipment for the entire period under study were financed from domestic sources.

Diagram 3. Sources of fixed capital investments in Azerbaijan's processing industry, including machinery and equipment manufacturing enterprises [6]

From 2017 to 2023, the global market value fluctuated under the influence of oil prices, declining in 2020 and increasing rapidly in subsequent years, reaching US$126.9 billion in 2023.

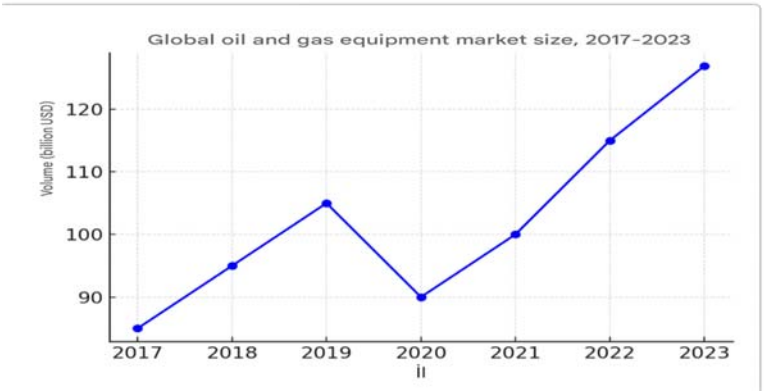

Chart 2. Annual volume of the global oil and gas equipment market (2017-2023)

[6] www.azstat.org.

The research examines the share of production capacity in the field of petroleum engineering in the world, export indicators, labor productivity, and the experiences of foreign countries, and makes suggestions.

Chapter III of the dissertation entitled "**Directions for increasing the economic efficiency of the application of innovations in the field of oil machinery"** reflects the directions for increasing the efficiency of innovations newly applied to the production of machinery and equipment, the prospects for increasing the export-oriented innovative product production potential of machinery-building enterprises, and the ways to create an optimal relationship between innovation costs and production volume in machinery-building enterprises.

It is noted that the petroleum engineering industry is one of the economic sectors that combines high technologies, complex production systems, and strategic innovation approaches. The purpose of innovations applied in this field is not only product innovation, but also ensuring the efficiency, flexibility, and economic sustainability of the production process. Current research shows that innovation models applied in oil machinery manufacturing, including digitalization, automation, the use of highly durable materials and smart technologies, are significantly increasing the production capacity and export potential of the sector.

It is noted that there are several strategic approaches to increasing the efficiency of new technologies. These cover a wide range of areas, from the level of technical modernization to economic impacts. Digitalization and automation of technological processes, through the application of CAD/CAM, CNC and SCADA systems, increase processing accuracy, reduce energy consumption and optimize labor. Strengthening local innovation potential The establishment of R&D departments creates conditions for reducing technological dependence and developing local human resources.

The research study examines the changes in the volume of investments directed to the improvement of the oil machinery manufacturing industry in countries around the world and identifies the trend of change.

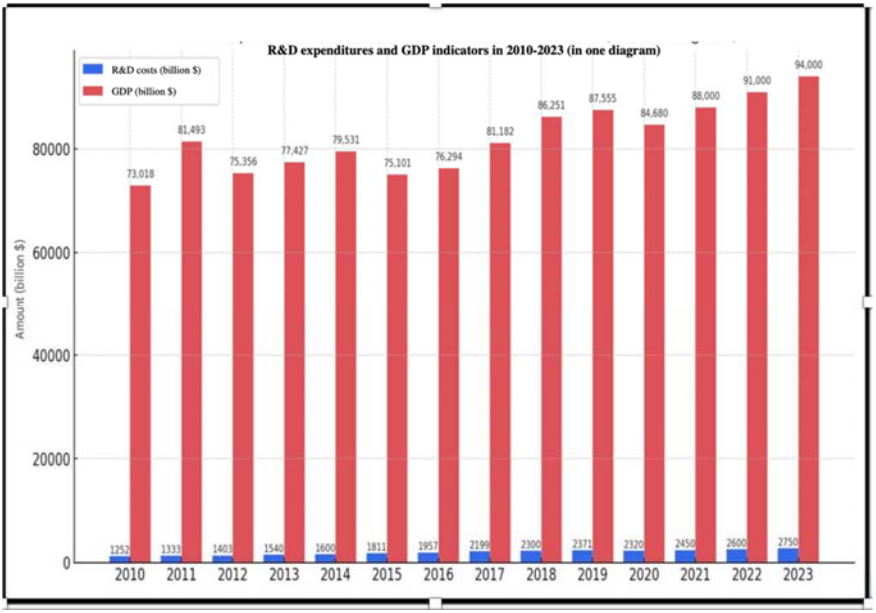

Diagram 4. The volume of investments directed to the improvement of worldwide research and development (R&D) in 2010-2023

As can be seen from the diagram, worldwide R&D (research and development) spending and GDP grew in parallel between 2010 and 2023. The sharpest increase is observed in 2021–2023, which is due to increased investments in technology and research during the recovery period after the pandemic. In 2023, R&D spending reached an all-time high, approaching $2.75 trillion. This growth reflects the increasing focus on innovation, artificial intelligence, green technologies, and digitalization.

The fact that both indicators are presented in the same time interval in the diagram visually demonstrates their relationship with each other. The fact that the increase in R&D spending is positively correlated with GDP proves how effective technology investments are in economic growth.

The potential of the petroleum engineering industry in Azerbaijan is being explored and areas of specialization have been identified.

Table 3

Main oil machinery manufacturing enterprises operating in Azerbaijan

Enterprises	Year of establishment	Specialization (main products)	Number of employees	Export Markets / Certificates
Baku Petroleum Machine-Building Plant	2010 (based on 1900 and 1940s)	Equipment for drilling and repair of wells (fountain fittings, drilling rotors, valves)	314	Ukraine, Russia (export);
"Baku Worker Machine-Building Plant"	1900 (merged with the Keshla factory)	Jacks (rod well pumps), lifting cranes, drilling units	380	Kazakhstan (export); ISO 9001 certified
"Surakhani Machine-Building Plant"	1926	Underground oilfield equipment (deep well pumps, gas lift valves, packers)	368	Kazakhstan, Russia (export); API and ISO certified
Zabrat Machine-Building Plant	1921	Spiral towers, metal structures (spirals)	118	Russia (export); API and ISO certified
“Machine-Building Plant after B.Sardarov”	1926	Fountain fittings, valves, rotary cranes	210	Russia (export)

Source: *Prepared by the author based on collected materials.*

The above enterprises constitute the core of the oil machinery complex of Azerbaijan. They produce a wide range of products such as drilling rigs, oil production equipment, pumps, well equipment, spare parts for oilfield operation. As a result of the introduction of innovations in the mentioned enterprises and the use of new equipment, the products were sold not only to local enterprises, but also, as mentioned, to foreign markets.

The study shows that Azerbaijan's oil machinery industry is weak in terms of innovative product production, lacks competition, and lacks funding. In this regard, strategic directions are being identified to strengthen innovation and export potential:

- digitalization and technological modernization;
- creation of new innovative products;
- technology transfer and foreign partnerships;
- quality infrastructure;
- state support and industrial policy measures;
- implementation of regional market strategy and marketing-oriented reforms.

The research identified 6 areas for creating optimal relationships between innovation costs and production in mechanical engineering enterprises.

- targeting of innovation investments;
- state support;
- development of human resources;
- digitalization of the production process;
- cooperation and clustering;
- measurement of results and continuous analysis.

As a result of our research on the application of innovations in the field of mechanical engineering and their economic efficiency, it was determined that in countries with high scientific capacity, the production volume of innovative products and their export orientation develops at a higher rate than in other countries. The basis of manufactured products on innovations creates conditions for an increase in the level of scientific and research activity in enterprises due to the increase in scientific capacity.

CONCLUSION

The application of innovation processes in the production of machinery and equipment plays a significant role in increasing profitability and reducing costs, while also ensuring ecological safety for human health and the environment, as well as contributing to sustainable development and the safety of production and labor

protection. In this regard, the application of innovations in the field of mechanical engineering has identified ways to increase their economic efficiency, and several theoretical and practical results have been obtained during the research:

- The research has determined that in order to ensure the sustainable competitiveness of a mechanical engineering enterprise in both domestic and international market conditions, one of the key tasks during the organization of innovation processes is to consider the features of the functions of employees engaged in the core activities related to innovative operations.
- The implementation of various types of innovations in management increases the efficiency of the production process, optimizes workflows within enterprises, and improves product quality.
- To ensure the sustainable competitiveness of mechanical engineering enterprises in foreign markets, it is essential to take into account the functions related to employees' innovative activities when managing the innovation process. Without organizing innovative activity, it is practically impossible to increase the productivity of equipment and personnel.
- To improve the production process, the continuous implementation of a process for searching, developing, and applying innovations should be formed in accordance with international experience, and this structure should become an integral part of the responsibilities of managers and executives at all levels of management.
- Establishing an optimal relationship between innovation costs and production volume enables the enterprise to increase profitability.
- The impact of certain macroeconomic indicators on the innovation activity of enterprises and a scheme of the requirements for innovative development have been developed. The role of the financial reserves of an enterprise in relation to macroeconomic factors in the implementation of innovation policy has been clarified. Since the application of innovative solutions requires considerable financial resources, the lack of financial means and non-utilization of

innovations weakens the innovation potential of enterprises.

- It has been determined that alignment with international standards and certification is essential to expand the export-oriented product portfolio.
- The innovation activity of enterprises is positively influenced by a high amount of information about modern innovative technologies and products. On the contrary, insufficient information about consumers of modern innovation technologies and information products results in decreased demand for innovative products.
- The decline in state support for innovative activities in enterprises under current conditions slows innovative development by weakening the conditions for the development of cooperation links among innovation-structured enterprises in the real sector.
- The costs of R&D (Research and Development) have a positive impact on the increase of new innovative product volume through the application of innovative technologies, thus stimulating economic growth and also contributing to solving global ecological problems. In this respect, R&D regulation is necessary for the innovative development of the oil and gas industry.
- Since global R&D expenditures are science-intensive, salaries account for 26% of the total costs, direct material costs make up 15.08%, and indirect costs account for 14%. The 14% share of indirect costs in R&D expenses shows that, in terms of value, indirect costs are higher than direct costs relative to employee wages involved in R&D.
- Based on the conducted research, measures implemented in the oil sector of the Republic of Azerbaijan within Regional Development Programs have led to an increase in output due to the increased productivity of wells operated in the oil and gas industry as a result of the application of new techniques and technologies.

The characteristics of forming a management mechanism for innovation activity in the production of machinery and equipment have been studied, analyzed, and the following proposals have been grouped:

- Strengthening the institutional foundations of innovation management: To organize innovation activities effectively in the

machinery and equipment industry, specialized management structures should be created at the state level, and industrial clusters should be encouraged.

- Application of state financing mechanisms for innovation projects: Financial instruments such as concessional loans, grants, and tax incentives should be expanded to implement high-tech projects.
- Networking of technoparks and innovation centers: The integration of technoparks with scientific institutions and the industrial sector should be ensured, and coordination in strengthening innovation infrastructure should be increased.
- Application of flexible management models: The implementation of Agile, Lean, and other flexible management methods in industrial enterprises can accelerate innovation processes and enable result-oriented management.
- Expansion of human capital-based management approaches: Cooperation mechanisms between enterprises and higher education institutions should be established to train and continuously develop qualified specialists.
- Deepening digitalization in innovation processes: The application of digital management systems such as ERP, CRM, etc., in industrial enterprises should be increased, and digital transformation should be encouraged to enable data-driven decision-making.

In the oil machinery engineering sector, the following proposals have been made to increase innovation efficiency:

- The digitalization of innovation processes should be expanded. The application of automated design, production, and monitoring technologies can enhance production accuracy and efficiency.
- Support for the activities of local R&D centers should be strengthened. Local engineering and technological research centers should serve as a foundational base for creating innovative products.
- The use of new materials resistant to corrosion and high pressure should be encouraged. This can extend the operational life of equipment and reduce maintenance costs.
- Industry-university collaboration should be systematically

organized. Joint projects, internship programs, and technological incubation initiatives can accelerate innovation transfer.

- Technological transfer centers should be established for the commercialization of innovation projects. Legal and financial support mechanisms for the market launch of new technologies should be simplified.
- Tax and financial incentives should be implemented within public-private partnership mechanisms. Technology funds and startup support with concessional conditions should be provided to attract additional investments.

As a result of the research, it has been determined that to apply innovations and enhance economic efficiency in oil machinery enterprises in the Republic of Azerbaijan, in addition to optimizing expenses on scientific-research and design-construction works, the development of clusters in the oil machinery industry and the use of experience from countries with high science intensity should be prioritized. All of these will contribute to enhancing the competitiveness of Azerbaijan's oil machinery industry's innovative product manufacturing in the science-intensive product market and will foster the development of other sectors of the economy. From this perspective, the country's innovation strategy should integrate the development of scientifically capable personnel, the enterprise's resource potential, and specific innovative projects.

The following scientific articles and theses of the author have been published regarding the main provisions of the dissertation work, the results obtained, and the proposals:

1. Sharifli, I.E., Assessment of factors affecting product production at oil machinery enterprises. // – Baku: Audit Journal, 2021, № 3. – s. 105-115.

2. Sharifli, I.E., The role of innovation management in the development of the oil and gas sector of Azerbaijan. // – Baku: Audit Journal, 2022, № 2. – s. 53-61.

3. Sharifli, I.E., The impact of innovation costs on the financial and economic activities of the Baku Workers' Machine-Building

Plant Limited Liability Company. // – Baku: Journal of Tourism and Hospitality, 2022, № 1. – s. 70-79.

4. Sharifli, I.E., Assessment of the activities of oil machinery enterprises in the Republic of Azerbaijan // – Nakhchivan: Journal of Scientific Works, 2022 № 3. – s. 75-82.

5. Sharifli, I.E., Theoretical issues of the restructuring of the machine-building industry. // – Baku: Odlar Yurdu University, Republican Scientific and Practical Conference of Doctoral Students and Young Researchers dedicated to the 99th anniversary of the birth of the National Leader Heydar Aliyev, May 4, 2022. – s. 497-501

6. Sharifli, I.E., Organizational forms of innovation processes in industrial enterprises and the innovative cycle. // – Baku: Baku Business University, Materials of the International Scientific-Practical Conference on "Global Economic Challenges: Main Directions of Socio-Economic Development in the Liberated Territories of Azerbaijan" dedicated to the 98th anniversary of the birth of the National Leader Heydar Aliyev, May 6, 2021. – s. 327-331.

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9. Sharifli, I.E., Main directions of the state innovation policy // – Baku: Materials of the Republican scientific-practical conference on the topic "Strategic Roadmap for the prospective development of the national economy: directions of human capital formation" dedicated to the 70th anniversary of the birth of I.H. Ibrahimov, January 26, 2018. – s. 167-175.

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11. Sharifli, I.E., The influence of innovative costs in machinery construction on tax payments // – Moscow: Economics № 1(51), 2022, – p. 75-82.

12. Sharifli, I.E., Assessment of the impact petroleum engineering on GDP // – Italy: V International Scientific and Practical Conference Innovations and prospects of world science, 2022. – p. 470-475.

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Address: AZ1106, Azerbaijan Republic, Baku city, Najaf Narimanov Street, 93.

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