

# REPUBLIC OF AZERBAIJAN

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## ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

### **RATIONAL DIRECTIONS OF INTEGRATION OF PETROCHEMICAL INDUSTRY OF AZERBAIJAN INTO THE WORLD MARKET IN THE CONTEXT OF VALUE CHAIN EXTENSION**

Speciality: 5310.01 - The World Economy

Field of science: Economic sciences

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**BAKU - 2022**

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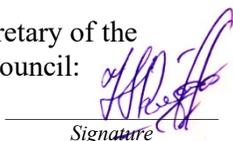
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## GENERAL CHARACTERISTICS

**Relevance and research degree.** Much has been done and is being done in recent years to diversify the economy of Azerbaijan. The aim is to create more value in the non-oil sector, and reduce the dependence of the state budget and the exchange rate on oil. The most valuable fields of the non-oil sector are industry. The development of industries, along with meeting domestic demand, causes an increase in exports, which in turn results in an increase in the country's foreign exchange reserves. The growth dynamics of the industry varies according to the country's economic power and income level.

Oil and gas exporting countries are constantly focusing on the development of the petrochemical industry to reduce the impact of price fluctuations in the market on their economies. Loss caused by the fall in oil and gas prices is offset by revenues from the sale of petrochemical products. When oil and gas prices fall, the cost of raw materials used in the production of petrochemical products decreases, as a result, the cost of these products also decreases and the sales revenue increases. Therefore, as a country whose economy is strongly dependent on oil and gas exports, increasing the production and export of petrochemical products in Azerbaijan plays a crucial role in enhancing its economic sustainability.

In order to expand the export of petrochemical products, the production of these products within the country must be increased. Describing the value chain, determining the value increase in production processes at the link level, identifying the maximum production in each link, and exploring the possibility of organizing production in other links of the value chain are of vital importance in the organization of production of petrochemical products. Therefore, there is a need to study production and exports in the context of the value chain.

Since the investment projects conducted to increase petrochemical products are large-scale and long-term, it is very significant to ensure the development of modern methods, using the analysis of international experience in the implementation of these projects, as well as the detection, assessment and management of

potential risks in petrochemical enterprises within the framework of relevant international standards after the completion of such projects. The petrochemical enterprise's risk management system should be based on the analysis of foreign risk management systems, taking into account sectoral and local characteristics. These systems are considered to be substantial because they allow the detection, assessment, ranking, and management of risks.

The analysis of the world market for products produced in each link of the value chain of petrochemical products plays an essential role in the successful export of petrochemical products. These analyses allow to determine the volume of production of petrochemical products, to direct products to the most profitable markets, and to gain the maximum profit.

Today, the only way to increase the sustainability of Azerbaijan's economy is to improve the export potential by expanding the production of petrochemical products, one of the key areas of the non-oil sector, in the high value links in order to reduce the dependence on the export of raw materials. In this case, the relevance of this research work, which is dedicated to solve this problem and refers to the foreign experience, significantly increases.

The research works of foreign scholars on the subject has been systematically studied and a number of conceptual provisions contained in these works have been used.

Thus, the novelty of these problems and the importance of their solution for Azerbaijan, as well as the insufficient research on the rational directions of integration of petrochemical industry in Azerbaijani into the world market in the context of the value chain extension are the main factors which determines the subject, purpose, and objectives of the research work, and intensifies its scientific and practical significance.

**Research purpose and objectives.** The research purpose of the dissertation is to analyse the experience of East Germany's reconstruction of its chemical industry, to learn international experience in risk management in the chemical industry, to study the competitiveness and innovation system of the German chemical industry, to explore the possibilities for progress in the value chain of

petrochemical products in Azerbaijan on the basis of the analysis of the world markets of the main petrochemical products, and to assess the impact of this progress on the trade balance.

To achieve this purpose, the following objectives have been set and fulfilled:

- A comprehensive study of the current state of production and export of petrochemical products in the value chain of the country;
- A comparative analysis of the conceptual basis of the reconstruction of the chemical industries of East Germany and Azerbaijan;
- A study of the organization of risk management in the chemical industry in accordance with international standards;
- A study of the competitiveness of the chemical industry, the innovation system, and the innovation culture of Germany;
- An analysis of world markets for basic petrochemical products, polymers of these products, and urea (also known as carbamide);
- A systematic analysis of the dynamics of development of petrochemical products along the links of the value chain;
- Assessment of the impact of the increase in the production of petrochemical products on the trade balance.

**Research methods.** The methodological basis of the dissertation includes the methods and forms of scientific research accepted in Economics. Systematic, logical, historical, comparative, prognostic general scientific methods, as well as the method of complex economic analysis have been used as tools and methods of this scientific research. Competitiveness has been studied using the constant market share method, and the impact of key drivers affecting competitiveness has been determined using EViews.

**The main provisions of the defense.** The following provisions are defended in the dissertation:

1. The current state of production and export of petrochemical products in Azerbaijan at the link level of the value chain of petrochemical products has been analysed, the main problems of this area has been studied, and the need to use East

Germany's experience of restructuring its chemical industry has been noted.

2. The model of phased development of petrochemical enterprises projects, the methods of risk assessment in these projects, the most common international standards applied in the field of risk management, and the organization of risk management in the German chemical company BASF have been discussed.
3. By applying the constant market shares method, the competitiveness of chemical products in the German chemical industry sectors and the strength of drivers affecting them have been determined. One of the main drivers affecting competitiveness has been identified as innovation, as well as the factors influencing the German innovation system, and the sales of innovative products have been analysed.
4. The main trends and development factors of the world markets of petrochemical products and the export opportunities of Azerbaijan's intermediate petrochemical products to these markets have been analysed. The impact of the incompleteness of the value chain of petrochemical products of Azerbaijan on the trade balance has been evaluated. The existing problems in the organization of production in accordance with the last link of the value chain, and the ways to overcome these problems have been shown.

**Scientific novelty of the research.** The scientific novelty of the research is based on, for the first time in the country, the study of the current state and prospects of production of petrochemical products in the value chain, the analysis of world markets of petrochemical products, the analysis of prospects for Azerbaijan's petrochemical products in world and regional markets, the identification of the problems causing the incompleteness of the value chain and the ways to overcome these problems, and the assessment of the impact of increasing production along the value chain links and completing the value chain on the trade balance.

The scientific novelties obtained in the dissertation can be summarized as follows:

- The structure and block diagram of the value chain of

petrochemical products have been developed, the creation of value in the value chain has been evaluated, and the main features and problems of petrochemical production in Azerbaijan with respect to the links of value chain have been identified:

- The risk classification of petrochemical enterprises has been provided and the model of risk management in these enterprises has been formed;
- The stages of reconstruction of the chemical industry of East Germany during the transition period from the administrative-command system to the market economy, and the features of the implementation of reconstruction in these stages have been revealed;
- The author’s interpretation of the constant market share method and of the assessment of the share of competitiveness and structural changes in the change of market shares of German chemical products in different periods with the application of this method has been presented;
- The key to the success of the German chemical industry in the production of innovative products has been found to be related to the characteristics of its national innovation and management system, and the author’s interpretation of the correction factor method, which allows to estimate sales volume of innovative products has been provided;
- The characteristics and differences of innovation cultures of East and West Germany have been revealed;
- The main trends in the development of the world petrochemical market, and the role and prospects of Azerbaijan in this market have been identified;
- The impact of the completion of the value chain of petrochemical products in Azerbaijan on the trade balance has been assessed.

**Theoretical and practical significance of the research.** The theoretical and practical significance of the research lies in the fact that its main provisions, results and proposals can be applied at the enterprises of “Azerkimya” Production Association, “SOCAR

Polymer”, Carbamide Plant, Oil, Gas Processing and Petrochemical Complex (OGPPC), as well as in the compilation of new road maps, laws and decisions in the field of petrochemical industry, in scientific researches, and in the higher educational subjects, in particular, “World Economy”, “International Economic Relations”, “World Commodity Markets”, and “Management of Foreign Economic Activity”.

**Approbation and application of the research.** The main provisions of the dissertation and proposals arising from the research have been discussed and approved at national, regional, and international scientific conferences and seminars. The scientifically substantiated recommendations reflecting the main essence of the dissertation are reflected in 14 scientific works published in the volume of 7-9 printed pages.

**Name of the organization where the research work has been conducted.** The dissertation has been completed at the Institute for Scientific Research on Economic Reforms of the Ministry of Economy of the Republic of Azerbaijan.

**Total volume of the dissertation with characters, indicating the volume of the structural units of the dissertation separately.** The introduction (13220 marks), three chapters (Chapter I - 91923 marks, Chapter II - 74172marks, Chapter III -63183 marks), results (9954 marks), a list of 162 references used. The dissertation is 159 pages long, with 25 figure and 15 tables organized according to the logic and essence of the work.

## SUMMARY OF THE DISSERTATION

The dissertation consists of an introduction, three chapters, conclusion and a bibliographic list of references. The introduction of the dissertation substantiates the relevance of the research topic, the purpose and objectives of the research, the main provisions of the defence, the scientific novelty, and the practical significance of the results obtained.

**The First Chapter** of the dissertation explores the theoretical and methodological aspects of the rational directions of integration of the Azerbaijani petrochemical industry into the world market in the

context of extending the value chain. The production of petrochemical products is divided into stages, the value created at each stage during the transportation of the product to the consumer is estimated and the increase in value is described by the value chain (Figure 1). It is determined that, in the last link of the petrochemical value chain, prices increase 11 times compared to the original prices. The cost of a high-tech polymer product is 20 times higher than the initial price. Therefore, the value chain of petrochemical products can also be called a value multiplier.

Oil and natural gas production	Oil and gas refining, production of oil products and compressed gases	Production of base semi-finished products	Production of large tonnage polymers, oil and gas-based chemicals	Production of polymer products and high-tech products
Crude oil and natural gas	Naphtha, ethane, propane, butane	Ethylene, propylene, butadiene, benzene, toluene, methanol, etc.	I. Plastics, synthetic rubber, oil and gas based chemicals II. Special polymers, high-tech oil and gas-based chemicals	Polymer products, science-intensive products, special polymers
Price of raw materials 100%	Price of raw materials for oil and gas chemical industry +150%	Price of base semi-finished products +206%	Price of Group I products +145% Price of Group II products +213%	Price of product +170%
Price ratio 1	1.5	3.1	4.6-6.6	8-11



**Figure 1. Value-added chain in petro chemistry and increase in product prices along value chain links**

The volume of production of the most important types of chemical products in Azerbaijan in 2014-2020 in kind is given in Table 1. During these years, the production of the main petrochemical products – ethylene and propylene - was about one hundred thousand tons; about the same amount of polyethylene was produced. In 2014-2016, the products of the chemical industry accounted for 0.2% of GDP, and in 2017 and 2018 – 0.3%. It was not possible to eliminate Azerbaijan’s

dependence on the import of chemical products. In 2020, the share of chemical products in imports was 10.6%, and the share in exports was 0.6%.

Instead of expressing trade statistics in Azerbaijan by the value of goods, it was noted that these indicators should be included in the TiVA database, which includes the expression of economic indicators in value-added terms and value-added economic indicators in most countries of the world. Value-added trade, adopted by most countries of the world, along with the elimination of double counting, demonstrates very well the contribution of domestic economic sectors to exports.

Among the value-added activities in the global value chain, formed as a result of the deepening of the international division of labor, the smallest value-added is in manufacturing and assembly activities, and the largest value-added is in research/innovation. and marketing activities.

**Table 1. Production volume of the most important types of chemical products in kind**

	2014	2015	2016	2017	2018	2019	2020
Isopropyl alcohol, in thousand tons	10,6	12,3	8,9	11,9	7,3	-	5,8
Ethylene, in thousand tons	104	106,7	103,4	96,0	98,9	117,2	133,22
Polyethylene, min ton including commodity	101 99,8	103,5 101,5	100,3 100,3	93,2 93,2	96 96	95,5 95,5	132,2 132,2
Propylene, in thousand tons including commodity	56,5 45,6	56,4 56,4	52,2 52,2	48,4 48,4	56,2 56,2	88,1 87,5	103,3 97,5
Soft soap, in thousand tons	0.7	0.3	0.3	0.2	1,9	0,387	0.387
Synthetic detergents, in thousand tons	0.3	0.1	1,2	0,4	0.3	1,8	1,6
Paints and varnishes, in thousand tons	4,3	5,5	8,4	11,5	15,1	29,9	16,3
Polymer coatings, in thousand tons	0.01	0.02	0.001	-	-	-	-
Plastic door and window blocks, in thousand pieces	145,0	90,3	62.3	63,6	67,7	78,2	61,6

The dissertation emphasizes the need to use existing international experience in the evaluation, selection and phased implementation of the current Oil, Gas Processing and Petrochemical Complex (GPC) project in Garadagh and such future projects, focuses on the creation of the phased development model of such projects, discusses the work to be done in stages of the long-term development plan of oil and gas chemical complexes using mathematical-economic and forecasting methods, provides the classification of major risks in the field of petrochemistry, recommends the methods in the field of risk management, and takes into consideration the importance of involving international engineering companies along with the development of specific risk management plans. The dissertation also provides the comparative analysis of the most common international standards applied in the field of risk management.

In addition, the measures taken in the field of risk management in the German company BASF have been analysed. At BASF, risk is seen not only as an unpleasant event, but also as an opportunity for additional income. Risk management in the company is supervised by the Director of Corporate Audit and Control. The director of the control office reports monthly to the board of executive directors on risk management. The corporate audit reports to the board of directors on the work done to improve the risk management system. BASF monitors ranked risks on a monthly basis in accordance with a pre-approved business plan. Depending on the duration of the activity, business plans are operational, medium-term and long-term. An operational business plan is drawn up for a period of up to one year, a medium-term business plan for a period of one to three years and a long-term business plan for a period of three to ten years.

The reconstruction of East Germany's (GDR) chemical industry during the transition from an administrative-command system to a market economy has been explored, the competent privatization and decentralization of the plants as the basis for the establishment of the chemical industry, which produced competitive products in a short period of time on the basis of large chemical plants during the socialism period in East Germany (GDR), after the unification of the

two German states in 1990 has been considered, as well as the creation of chemical parks on the territory of the plants, support of enterprises operating in these parks by the European Union and the state, purposeful cluster policy of several chemical parks (local clusters), and organization of regional chemistry clusters based on the application of advanced technologies and innovations in the production process and coordinating bodies.

By the Decree of the President of the Republic of Azerbaijan Ilham Aliyev dated December 21, 2011, Sumgayit Chemical Industrial Park was established in order to reduce the country's dependence on oil and gas exports, and develop oil-gas chemical industry. The purpose of creating this park was to create conditions for the activities of private companies working in the field of petrochemistry, and complementing and supporting each other in the value chain. Residents currently operating in the park are not linked to each other by a value chain. In order to form a cluster in this park in the future, it must be ensured that the entire value chain required for the final product is available within the park. In other words, the value chain within the park must be strengthened. To ensure the participation of the state in this park, the Institute of Polymer Materials of ANAS should become a supporting institute of the park, pay special attention to conducting innovative scientific research, training in foreign countries, and supplying the institute with modern equipment.

**The Second Chapter** examines the role of innovation in the value chain of petrochemical products on the example of Germany. It was noted that, the great achievements of the German chemical industry have been achieved through the production of high-tech, science-intensive products in the last links of the value-added chain. The competitiveness of these products is created by their consumer value. For this reason, a product that is produced with the application of more advanced technologies in any link in the value chain of chemical products and causes more added value than other manufacturers has a greater consumer value and is considered competitive. In general, the competitiveness of a product is determined not by its low price, but by its consumer value. In this sense, competitiveness is of capital importance in the analysis of the value-added chain. Thus, the analysis

of competitiveness allows us to determine the role of leading drivers in the creation of consumer value, in other words, added-value. There are many methods for analysing competitiveness. One of these methods and the most common is the constant market share (CMS) method. This method separates the trade indicators of the studied country from the world trade indicators and compares the separated indicators with the trade flows of the rest of the world. The basic equation of the constant market share method is as follows:

$$q^t \equiv \sum_k q_k^t = \sum_k p_k^t Q_k^t \quad (1)$$

or alternatively:

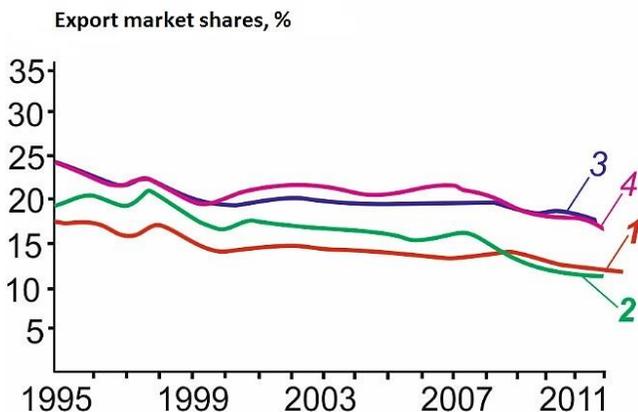
$$p^t = \sum_k p_k^t P_k^t \quad (2)$$

Here,

$q^t$  - total exports of the country under study;  $q_k^t$  - export of  $k$  goods of this country; export of  $Q_k^t$  -  $k$  to the world market;  $p^t$  - total export share of the country under study in total world exports;  $p_k^t = \frac{q_k^t}{Q_k^t}$  - the share of the country's  $k$  goods in total world exports of  $k$  goods;  $P_k^t = \frac{Q_k^t}{\sum_k Q_k^t}$  - the share of  $k$  goods in world exports;  $t$  -time. By differentiating equation (2) over time, a simple mathematical expression of the constant market share method can be obtained:

$$\frac{dp^t}{dt} = \sum_k p_k^t \frac{dP_k^t}{dt} + \sum_k P_k^t \frac{dp_k^t}{dt} \quad (3)$$

The change in the total export share of the country under study in total world exports is divided into  $\frac{dp^t}{dt}$  two elements: the structural effect due to changes in the share of goods in world trade  $\sum_k p_k^t \frac{dP_k^t}{dt}$  and the effect of competitiveness measured by changes in export shares for each commodity. By means of the equation (3), the difference between the average annual change in export market shares of a number of sectors of the German chemical industry (Figure 2) and the change in the corresponding world market share between 1995 and 2012, and the resulting structural change with the competitiveness effect have been identified.



**Figure 2. Export market shares of the German chemical collection (Curve 1). Export market shares by sector of polymers (Curve 2), special chemicals (Curve 3), and plastics (Curve 4).**

Labour costs, energy and raw material costs, exchange rates, public policy, innovations, and investments have been identified as key drivers of change in competitiveness, the strengths of these drivers have been studied, and it has been shown that innovations play an important role in increasing competitiveness. As a result of the study, it was noted that one of the factors affecting competitiveness and the first is innovation. Innovative activity in the chemical industry in Azerbaijan is low. This is due to poor links between science and industry, lack of information on new technologies and sales markets, inadequate support for new ideas, technical and technological backwardness, lack of implementation of innovation projects, lack of leading science centres and design bureaus, and lack of legislative documents encouraging and regulating innovation. There are few funds allocated for innovations in the chemical industry. The state neither allocates funds for this activity nor attracts foreign investment. These funds are mainly the funds of the enterprises (Table 2). In order to increase the level of innovative activity in the chemical industry of Azerbaijan, it was recommended to eliminate the above-mentioned shortcomings.

**Table 2. Expenditures on technological innovations by types of activities and financial sources in Azerbaijan, in thousand manats**

	2016	2017	2018	2019	2020
The whole industry	27929,0	16135,7	34353,6	48037,1	35919,8
Enterprises at their own expense	14286,5	16076,0	34278,0	47319,7	17631,5
State budget	-	-	3,6	-	-
Foreign investment	1180,2	36,0	72,0	-	-
Other	1834,3	23,7	-	-	-
Processing industry	27744,4	16104,0	32967,6	47658,5	34918,7
Enterprises at their own expense	14101,9	16044,3	32892,0	46999,5	17005,7
State budget	-	-	3,6	-	-
Foreign investment	11808,2	36,0	72,0	-	-
Other	1934,3	23,7	-	-	-
Chemical industry	180,7	664,7	215,4	-	-
Enterprises at their own expense	180,7	664,7	215,4	-	-

Recently, no money has been spent on research and development in the chemical industry. In 2018, 42.7 thousand manats have been spent on the application and development of new products, services, new processes in the chemical industry, 171.7 thousand manats on the purchase of machinery and equipment related to technological innovations, a thousand manats on the services of external organizations, and no money on scientific researches.

Since the national innovation system reflects the interaction of state and private structures that produce high-tech products and commercialize these products within favourable investment terms, the organization of an effective national innovation system is a very vital issue for any country. Because successfully commercialized innovative products ensure economic sustainability and social stability in society. To study the national innovation systems, management and innovation management of other countries enables to gain unique management experience that can be applied in our country and companies. Therefore, the German innovation and management systems - the activities of the world petrochemical giant BASF in these areas have been studied. The dissertation identifies the principles on which the innovation policy pursued at the federal government level is

based, shows the methods of financing innovation in Germany, and identifies areas for the distribution of financial support to stimulate promising scientific - research and experimental - design works.

The world leader in the petrochemical industry, the German company BASF, possesses a solid list of innovative products. The scientific-research network of this company has been analysed, in addition, the financial resources allocated for innovations, the innovative products

released by the segments, and the income from the sale of these products have been shown.

The experience of developed foreign countries is widely used in solving the problems of formation of innovation culture, which leads to the development of an innovative society. The experience of a unified Germany formed from the unification of socialist – GDR and capitalist –GFR is important for countries that have witnessed the transition from socialism to capitalism such as Azerbaijan. Thus, the features of innovation culture in West and East Germany have been studied.

**The Third Chapter** examines the world markets of ethylene, propylene and their polymers, and urea, as well as identifies the role and place of Azerbaijan in these markets. In these markets for five years (2015-2020), the demand for these products has been analysed, the demand and the production capacity, the increase in demand and the increase of production capacity have been compared, and the Turkish market, which is the main export market for petrochemical products of Azerbaijan, has been studied.

Price equilibrium, factors affecting the price, and demand and supply of ethylene, propylene and their polymers in European, North American, and Asian markets have been analysed.

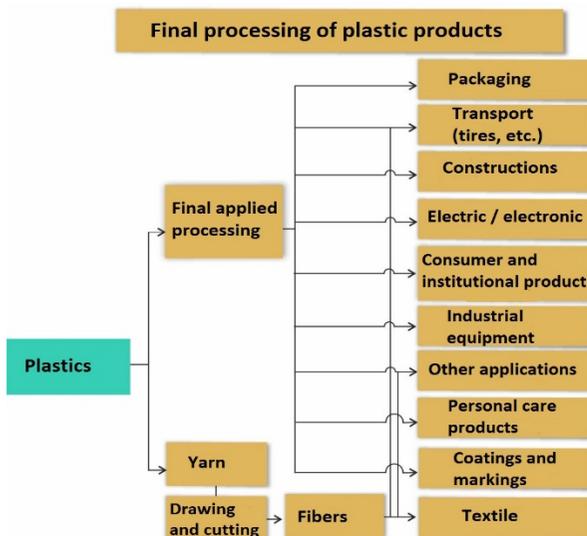
Competition between the main producers of petrochemical products in the second and third links of the value chain is aimed at reducing the cost, where raw materials play a crucial role. In recent years, the production of cheap shale gas-based ethane has allowed North American producers to compete with Middle Eastern producers, who have traditionally produced the lowest cost polyethylene, as well as stimulated cheaper raw materials and new production facilities. In

addition to naphtha and ethane, coal is also used as a raw material in the production of polyethylene in China. The price of coal in China is very low, so the production of polyethylene based on it is very profitable, and the role of coal in the production of polyethylene can be compared with the role of ethane in similar production in Saudi Arabia. The main driver of polyethylene production in both countries is local and cheap raw materials. In the future, the intensive development of polyethylene production in China will undoubtedly reduce imports, and this decline will have a negative impact on polyethylene exporters from the Middle East and the United States. If the United States launches its planned production capacity in the coming years, it will either have to remove Middle Eastern exporters from the Chinese market or reduce the burden on domestic production capacity. In any case, in the future, companies such as ExxonMobil, Dow Chemicals, and Chevron will be forced to use their production capacity below full capacity.

The key to the success in such competitive markets is to find the optimal balance between the nature of the raw materials used, the technology, and the production capacity.

Although the rapid growth of Turkey's plastics industry is rapidly increasing domestic demand for polyethylene and polypropylene, domestic production is not enough to meet this demand. PETKIM is the only company producing polyethylene in Turkey. The company produces a total of 355,000 tons of polyethylene and 144,000 tons of polypropylene per year. In 2020, the domestic demand for polyethylene and polypropylene was 2.36 million tons and 2.676 million tons, respectively. Domestic demand is mainly met by imports, which Azerbaijan can take on by expanding polymer production.

The production process in accordance with the last link of the value chain of petrochemical products is the processing of plastic raw materials into plastic products. The sector diagram of the last link of the value chain is given in Figure 3.



**Figure 3. Sector diagram of the last link of the value chain of petrochemical products.**

Based on the volume of production of various types of polymers in Azerbaijan and domestic demand for these types of polymers, it was determined that the potential volume of exports of plastic raw materials in 2022 will not be less than 306.9 thousand tons. After the launch of SOCAR-GPC, the potential volume of plastic raw material exports is projected to be no less than 906.9 thousand tons. Given that the average import price of plastics in Turkey in 2020 was \$ 1119 / ton, export trade value of plastic raw materials in 2022 will not be less than \$ 343 million. From 2023, the balance of export trade value of plastic raw materials in Azerbaijan will not be less than \$ 1.014 billion.

Based on the average import of plastic raw materials and average export prices of plastic products in Turkey, it was determined that Turkey will earn at least \$ 1.07 billion in 2023 by processing plastic raw materials that Azerbaijan will export to this country and exporting them as plastic products. In order not to lose these funds, Azerbaijan must organize the processing of production plastics in accordance with the last link of the value chain of petrochemical products.

The main problems of the plastic processing sector in Azerbaijan are limited demand for polymer products by potential buyers (construction, utilities, transport, road construction); difficulties in obtaining raw materials, spare parts, materials (primarily in small business); staff shortages; dependence on imported equipment; and lack of marketing data for forecasting.

The development of the plastic processing industry of the petrochemical industry in Azerbaijan will play an essential role in increasing the sustainability of the country's economy. Because plastic processing is in fact a production process in accordance with the last link of the value chain of petrochemical products, i.e. the ultimate goal of polymer production. In other words, it is to realize all the advantages of this type of material in certain products.

## CONCLUSION

1. Based on the description of the value chain of petrochemical products and the analysis of the value obtained in the production processes in accordance with the chain links, it was determined that despite the current low share of petrochemicals in exports (in 2020 the share of chemicals was 0.6% in exports, while 10,6% in imports), the petrochemical industry has the potential to help free the country from dependence on raw material exports and increase the sustainability of the country's economy by creating high value [5].

In order for Azerbaijan's participation in the global value chain to increase the technical and technological potential of our economy and to enhance labour productivity, Azerbaijani companies are encouraged to thoroughly study the impact of this participation or of the increase in participation on the country's economy before participating in and expanding their participation in global value chains.

It was noted that the use of the term "added value" to characterize the process of trade in connection with the globalization of the value chain in modern times, while avoiding double counting in the structure of exports and imports, gives a clearer idea of the role and place of individual countries in the world division of labour. Taking into account the ever-expanding nature of scientific and

methodological field, and the fact that TiVA database, which contains more than 30 indicators of value-added foreign trade activity of the industry, allows conducting various researches to assess the impact of foreign trade activity on the economic development of individual countries and the world economy, it is recommended to work on the inclusion of economic indicators of Azerbaijan in this database [8].

2. In the evaluation of projects to be implemented in the field of petrochemistry, it is recommended to carry out Feasibility Study, FEED and EPC stages of projects with the involvement of international engineering companies with extensive experience in this field. Due to the importance of perfection and modernity of risk management systems applied in enterprises operating in the petrochemical industry, which is a high-risk business area, the best way to develop these systems is to select an appropriate risk management system using analysis of risk management systems applied in foreign companies and adapt the system to the activities of the local enterprise. It was determined that the risk management system implemented by the German company in the activity of BASF in accordance with COSO ERM standards is the most advanced system used in foreign companies operating in the petrochemical industry, and it is recommended to adapt this system to the characteristics of local enterprises [5, 4, 15].

3. In respect of the analysis of the organization of petrochemical value chain activities in clusters in East Germany, it was determined that after the unification of the two German states, chemical clusters producing competitive products in East Germany, has been established on the basis of the liquidation of inefficient chemical plants of the German Democratic Republic, the rehabilitation and privatization of efficient enterprises, the production sites where these vertically integrated enterprises operate, without changing their location, and the chemical parks, including a large number of legally independent firms. Regional chemistry clusters have been established based on the technological and institutional (through cluster initiatives) interactions of several local clusters with universities and research institutes. In East Germany, great attention was paid to the factors that affect competitiveness – the provision of skilled labour, the availability of new technologies and innovations in production [10].

4. Although the purpose of establishing the Sumgayit Chemical Industrial Park was to provide conditions for the activities of private companies operating in the field of petrochemistry, complementing and supporting each other in the value chain, residents are not related to each other in the value chain. In order to create a cluster in the future on the basis of this park, it is necessary to ensure that the entire value chain required for the final product is available within the park. In other words, the value chain must be extended within the park. The state should ensure the participation of the park in this work, make the Institute of Polymer Materials of ANAS a supporting institute of the park, and pay special attention to conducting innovative scientific researches, to training in foreign countries, and to supplying the institute with modern equipment [10].

5. Using the constant market share method, changes in the structure and competitiveness of German chemical products have been monitored. Econometric assessments showed that the competitiveness of the German petrochemical industry in the period under review was negatively affected by rising energy and raw material prices, labour costs, and strengthening of the euro, while innovations and investments had a positive impact. To increase the level of innovative activity in the chemical industry of Azerbaijan, it is recommended to strengthen the existing weak link between science and industry, to overcome the lack of information on new technologies and sales markets, to provide proper support for new ideas, to develop legislation encouraging and regulating innovation, to eliminate technical and technological backwardness, and to establish leading science centres and special design bureaus in the field [1].

6. A comprehensive analysis of Germany's innovation system and management shows that the country's achievements in innovations stand on its economic potential, effective public administration, the rational construction of research institutions, large investments in education and science, and on close relationships between scientific institutions, business community and government based structures. The study also focuses on the necessity to take into account the characteristics of the external market environment, the potential consumer audience and the factors of marketing efforts necessary for

the promotion of innovative products in the application of the model for assessing the penetration of innovative products into the market. It was determined that the basis of BASF's innovation system is closely bound with important scientific centres around the world, constant attention to improving the qualifications and scientific degrees of its employees, close contact with customers, and in-depth study of sales prospects of innovative products [2].

7. The analysis of researches on innovation culture in East and West Germany found that unlike West Germans who earn high incomes, constantly strive to increase their leisure time, and have a strong interest in innovation, Germans living in East Germany tend to avoid making and being responsible for free decisions, try to avoid risks, and show less interest in accepting innovations. Since the labour mentality in Azerbaijan, as in East Germany, is based on the attitude to labour in socialism, it is recommended that Azerbaijan work to adapt this mentality to the values of developed countries over time [11].

8. The analysis of world markets for ethylene and propylene determines that the region with the greatest demand for these products is Northeast Asia, the main exporting regions – North America and the Middle East, a balanced regional market for these products – Europe. It is estimated that the average annual demand for ethylene and propylene in 2015-2020 increased by 3.4% and 4%, respectively. It was also determined that the main factors influencing the prices of these products in the world markets of ethylene and propylene are the type and price of raw materials, applied technologies, shutdowns of production enterprises for various reasons, and arbitration. After 2021, an increase in demand for urea in the global urea market is expected. Based on this forecast, it is recommended to increase urea production in Azerbaijan several times and to fully supply the Turkish market on its own [6, 7].

9. It is noted that the largest regional exporters of polyethylene are North America and the Middle East, and the largest importer is China. The largest regional markets for polyethylene are located in Northeast Asia, North America and Western Europe. Additional production facilities are being set up in North America, the Middle East and Northeast Asia. Competition in the market will be based

mainly on cheap raw materials and improvements in production technologies. Low-cost production in the US will be based on cheap ethane processed from shale gas and in China based on local cheap coal by means of CTO technology. Shale gas-based polyethylene production in the US will gradually put an end to world polyethylene prices by Middle Eastern producers. As the production of polyethylene based on coal in China increases, the market price will be determined by the producers of these three regions.

It was shown that the largest consumption of polypropylene is the Asia-Pacific region. In the global polypropylene market, competition is expected to intensify between North American and Chinese producers of polypropylene based on non-traditional raw materials (shale gas, coal, etc.) and the Middle East, the world's cheapest polypropylene producer. Although China continues to build new production facilities, it remains the world's largest importer of polypropylene [3, 12, and 13].

10. Existing problems in the organization of the production process - the production of plastics in accordance with the last link of the value chain of petrochemical products in Azerbaijan have been identified and ways to overcome them have been identified. The main problems of the plastic processing sector in Azerbaijan are limited demand for polymer products by potential buyers (construction, utilities, transport, road construction), difficulties in obtaining raw materials, spare parts, materials used (primarily in small business), staff shortage, dependence on imported equipment, and lack of marketing data for forecasting. As a result of the launch of new petrochemical enterprises, export-trade value for polymers in 2023 is projected to exceed \$ 1.013 billion, and the loss of funds will not be less than \$ 1.071 billion if the production of plastic products is not organized by that year. When establishing enterprises producing plastic products in Azerbaijan, it is recommended to solve the problem of optimal configuration of production capacities, production costs and markets and to choose the right product profile in the projects of these enterprises [14].

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The defense will be held on “24” june 2022 at FD 1.11. Dissertation council of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State University of Economics.

Address: AZ 1001, Baku, Istiglaliyat street 6

The dissertation is accessible at the Azerbaijan State University of Economics Library.

Electron versions of dissertation and its abstract are available on the official website of the Azerbaijan State University of Economics.

Abstract was sent to the required addresses on “24” may 2022.

Signed for print: 20.05.2022  
Paper format: 60x84 1/16.  
Volume: 07/05. Number of hard copies: 20  
(36445 Symbols)

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