



Integrated Management of Flows in Petroleum Products Supply Chains in the Field of Hydrocarbons Deep Processing

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ABSTRACT

The urgency of the problems stated in the article is reasoned by the fact that the requirements on the supply chain management system in the petrochemical industry become high on the basis of an integrated logistics concept. The purpose of the article is to develop methods to systematize the advantages of an integrated model of the petroleum products' supply chain. The leading approach to the study of this problem is the modeling method that allows assessing of the effectiveness of petroleum products' integrated supply chains. The article presents an analytical review of petroleum products' market development in the Tatarstan Republic. The content of integrated control of flows in the supply chain of petroleum products in the field of hydrocarbons' deep processing is disclosed. The submissions of the article have theoretical and practical significance for the development of models of the integrated supply chains management in the petrochemical industry.

Keywords: Supply Chain, Industry, Petroleum Products, Integrated Management, Petrochemical and Gas Complex

JEL Classifications: F15, L22, M11

1. INTRODUCTION

1.1. The Relevance of the Study

Currently, integrated management of flows in the supply chain is considered as a basic business strategy, allowing the company to increase the competitiveness and efficiency of the chain as a whole. To keep to the "Golden rule of logistics" - To drive the goods to the consumer at the right time, in required quantity, proper quality and cost-effectively, companies' managers must keep the cooperation and effective interaction with organizations in their supply chain.

The changes in the economy led to a revision of approaches to management of logistics systems of different levels and there was a transition from marketing logistics concepts to integrated logistics concept. The integrated approach involves integrated management of material, financial, information and service flows taking into account their interrelation and mutual influence. With the logistics' role increasing the level of logistics activities' integration is continuously increased both within the organization and between

the companies belonging to the same supply chain. To the study of flows and opportunities for their effective management the works of such Russian scientists as Mirotin et al. (2002), Meshalkin et al. (2003), Maslennikov (2007), Sergeev (2007), Mukhambetov and Bogdashkina (2013) and others are devoted. The application of the supply chain's integrated model contributes to the implementation of such key principles of business, as a time reduction of the functional cycle of new products' and services' supply and provides:

- Improving of the service's quality (value) of the customer
- Improving of the sales process
- Reduction of operating and production costs
- Cost reduction for stocks management.

2. METHODOLOGICAL FRAMEWORK

2.1. Research Methods

During research the following methods were used: Analysis, synthesis, system analysis, systematization and generalization of facts, modeling, comparison, description, analogies.

2.2. Theoretical Base of the Study

The theoretical basis of the study is formed of fundamental and applied works of foreign and domestic scientists, exploring the management models of integrated supply chains.

2.3. Stages of the Study

The study was conducted in three stages:

- In the first phase - The preparatory phase, the modern condition of the studied problem in the theory and practice of management of the integrated supply chains was analyzed; the program of research methodology was developed.
- At the second stage - The main stage - on the basis of statistical data the analysis of oil products' market at the mezzo-level was conducted on the example of Republic of Tatarstan; the main factors and trends of petroleum products chains' integrated management were systematized.
- At the third stage - The final stage - the systematization, interpretation and synthesis of the research results were carried out; theoretical conclusions were refined; the obtained results were processed and presented.

3. RESULTS

3.1. Integration, as an Important Use of Logistics Technologies

Logistic system is an adaptive, self-organizing system with feedback, to perform certain functions of logistics and logistics operations, consisting usually of several subsystems and possessing developed links with the environment. Most logistic systems have basic properties of complex systems: Hierarchic, integrity, structure, system, the impact of environmental factors that allow using of the system approach for their analysis and synthesis.

Analysis of historical and logical regularities of strategies' transformation of enterprise collaboration in the field of supply chain reveals that at present the most popular, cost-effective and appropriate in terms of competitive advantage are the integrated supply chains that will attract companies from various sectors of the economy to a joint business process management. At the same time the essence of the mechanism of strategic management in an integrated supply chain consists in the fact that the main managerial influence is carried out by the dominant organization with the greatest amount of resources (information, financial or material). It is distribution of orders for the products, which is required by the market and in building of a more efficient production and distribution system consisting of a plurality of independent contractor enterprises (Maslennikov, 2007).

The integration as an important area of logistics technologies' use should be based on the following conditions necessary for increasing of the presence share on market, growth in turnover and profit:

- Unified processes' management of all the flows: Material, financial and information throughout the value chain.
- Integration of all partners in the supply chain in order to achieve common goals.
- Elimination of information barriers between the managed

coordinated areas and development of modern information and communication technologies, which will provide uninterrupted and through movement of the information flow in accordance with the requirements (Shinkevich et al., 2015).

3.2. The Integrated Management Methodology of Supply Chains

Methodology of the integrated management of supply chains creates added value for the consumer. The model of integrated management includes costs' lowering, product quality's improving, flexible delivery and after-sales service. The application of new logistic methods and tools allow reducing of costs, increasing of productivity, improving of products' and services' quality, in the end, gaining of a competitive advantage in the marketplace.

Thus, the essence of the integrated management of products' flows in supply chains under conditions of strategic interaction is to coordinate by all stakeholders of the creation, production, sales, service and consumption of the final product by all participants in the product life cycle, sales, manufacturing, procurement, development and maintenance processes.

Integrated management of supply chains is associated with functional integration of purchasing, manufacturing, transportation and warehousing activities. It is also relevant to the environmental integration of these activities among geographically dispersed suppliers, infrastructure objects and markets. In addition, it considers inter-temporal integration of these activities within the strategic, tactical and operational management.

Inter-temporal integration requires linkages and a logical sequence of decisions on the supply chain at different levels of management. Inter-temporal integration is a key aspect to obtain sustainable competitive advantages of the company.

Another aspect of inter-temporal planning in the process of integrated management is the need to optimize the supply chain of the product taking into account its life cycle, i.e., in design stages, introduction, growth, maturity and decline. This in turn requires planning of life cycle and implementation of supply chain management and demand management.

There is a growing interest in the integration of companies' activities that create components of a single supply chain. It is obviously that such integration would improve the efficiency of the two companies' activities united by the merger. Another example could be joint actions of oil companies and the enterprises for primary and secondary processing of hydrocarbon raw materials. This is an example of a difficult integration because both companies have different suppliers and customers, i.e. their supply chains overlap partially, but are not identical. Advanced integration also involves the active exchange of confidential information about costs and capacities, and the management of business processes (Mirotin et al., 2002).

Thus, integrated management of flows in the supply chain of petroleum products can be seen as the integration of eight key business processes:

- Management of relationships with consumers
- Customers' service
- Demands' management
- Management of orders' execution
- Support of production processes
- Supply management
- Management of products' development and its bringing to commercial use
- Management of return materials' flows (Sergeev, 2007).

3.3. Specificity of Petroleum Products' Markets from the Point of Integrated Management

The oil products' market in the field of deep processing of hydrocarbons is characterized by the complexity and high level of ambiguity of the management process. Integrated management of products' flows in the supply chain of petroleum products in the field of deep processing of hydrocarbon raw materials can be defined as the configuration, coordination and continuous improvement of management of consequently organized operations' sets. The purpose of this management is to ensure the highest quality of customers' service at minimum possible cost. The company needs to maximize benefits and minimize costs across the supply chain, correlating the benefits compared with the costs for each solution, which is produced in the supply chain.

Currently, the main challenge facing the petrochemical industry is to minimize the cost of production and delivery of ready products to consumers, and a shift from the production of petroleum products of low level to a higher redistribution level. Thus, integrated management of product flows in supply chains of petroleum products will increase the efficiency and competitiveness of petrochemical enterprises and the chain as a whole.

Generally supply chain in the petrochemical industry can be summarized as follows: "Research" → "extraction" → "processing of low repartition" → "processing of higher value added" → "marketing" → "user."

The diagram illustrates the value chain in the petrochemical industry. A connection represents an interface between companies, as well as the main and associated streams that flow in the supply chain. Therefore, oil companies need service providers to develop a branch system and continuously being engaged in the entire supply chain.

At each stage of the integrated supply chain a set of operations is carried out. For example, the study includes seismic, geophysical and geological operations. Extraction includes drilling, production of reservoirs and engineering structures. The purpose of oil refining is the manufacture of petroleum products, primarily of different types of fuel (automotive, aviation, boiler, etc.) and raw materials for subsequent chemical processing. The primary processes do not involve chemical changes of oil and represent its physical separation into fractions. First industrial oil undergoes primary technological process of oil produced from oil gas, water and mechanical impurities - This process is called primary separation of oil. The purpose of secondary processes is the increase in the number of produced motor fuels. They are associated with

chemical modification of the molecules of the hydrocarbons contained in the oil composition, as a rule, with their conversion in a more convenient form of the oxidation. By the directions, all the secondary processes can be divided into 3 types:

1. Deepening: Catalytic cracking, thermal cracking, viscosity breaking, delayed coking, hydrocracking, the production of bitumen, etc.
2. Refining: Reforming, hydro-treating, isomerization, etc.
3. Other processes: Processes for the oils' production, MTBE, alkylation, aromatic hydrocarbons' production, etc. (Meshalkin et al., 2003).

Oil processing at the same time is an input stream for marketing. Marketing includes the retail sale of gasoline, motor oil and other petroleum products. At each stage the circuit connection involves the functioning of independent companies or divisions of corporations (Mukhambetov and Bogdashkina, 2013).

3.4. Development Trends of the Oil Market in the Republic of Tatarstan

In the framework of the objectives of this study it seems appropriate to consider the main trends of economic activities in "production of oil" on the example of Republic of Tatarstan. Oil production and refining sectors in the Republic of Tatarstan hold leading positions in the structure of the Russian production and implementation and actively participate in the global system of trade. Particularly significant are positions of the Republic at the Russian and international markets of oil, oil products, polymers, synthetic rubbers and tires.

The Russian market is an important market niche for products of petrochemical complex of the Republic of Tatarstan. In the sales structure of key enterprises of the complex the proportion of deliveries in the Russian regions is about 17%, including the enterprises of chemistry and petro-chemistry - 33%. Among the products of the complex, the largest share of shipments in the regions of Russia (in value terms): Tires for passenger cars (76%), polypropylene (73%), polystyrene (67%), tires for trucks (31%), polyethylene (52%) and diesel (32%).

Enterprise for products of petrochemical complex of the Republic of Tatarstan produce about 6.5% of the total volume of the products shipped by the Russian enterprises of oil production, oil refining, chemistry and petro-chemistry.

Foreign trade has traditionally played an important role in the development of petrochemical products' complex of the Republic of Tatarstan, contributing to the promotion of enterprises' complex of products, development of foreign economic relations, increase of foreign exchange, tax, investment income for further modernization of the economy.

Main enterprises-exporters are OJSC "Tatneft," OJSC "TAIF-NK," OJSC "Nizhnekamskneftekhim," JSC "Kazanorgsintez" - and they account for 97% of all exports. A significant The proportion of export in realization value is significant and at such enterprises as OJSC "Nizhnekamsktekhuglerod," tire manufacturing complex of JSC "Tatneft," JSC "Kazan plant of synthetic rubber."

The Republic of Tatarstan takes a significant specific place in the Russian export of oil, oil products, rubber, styrene, polystyrene, polyethylene, polypropylene, polycarbonate, carbon black, tires and synthetic detergents.

In the global production the highest positions Tatarstan takes on synthetic rubbers, Thiokol, neonol. The geography of export deliveries of petrochemical products of the Republic of Tatarstan covers the countries of the CIS, Europe, Asia, USA (The Program of Development of petrochemical complex of the Republic of Tatarstan in 2010-2014).

In the oil market of the Republic of Tatarstan in 2013 in comparison with 2012 there was an increase in the volume of production of diesel fuel, with a corresponding decrease in the production of volumes of furnace fuel oil and gasoline.

The sale of petroleum products is characterized by an increase in sales of residual fuel oil and diesel fuel, with a decrease in sales of volume of automotive gasoline.

The index of industrial production of petroleum products in 2013 in comparison with 2012 amounted to 97.9%, in December 2013 compared with November 2013 - 104.6%, compared to December 2012 - 104.3% (Figure 1).

The volume of oil received for recycling, in 2013 amounted to 103% compared to 2012. In 2013 the production of diesel fuel in the Republic amounted to 106.7% in comparison with 2012, gasoline 99.6% and residual fuel oil - 96.6%.

Enterprises and organizations of the Republic of Tatarstan in 2013 were shipped diesel fuel 4.9% more than in 2012, heating oil 5.8 times more, motor gasoline - by 3.8%. In total shipments of these types of oil products the share of consignees located in the territory of Tatarstan, was respectively 36.1%, 86.4% and 4.9% (Figure 2).

In the regions of the Russian Federation in 2013 residual fuel oil by 2.4 times more than in 2012 was supplied. Shipments of diesel fuel to the regions of Russia amounted to 78.6% in comparison with 2012, of gasoline to 75.6%. The supply share of basic types of oil products to the Russian regions (excluding the Republic of Tatarstan) in 2013 amounted to: Motor gasoline - by 3.3%, diesel fuel - by 6.2% and fuel oil - 8% (Federal State of Statistics Service).

The geography of oil products' deliveries to the regions of the Russian Federation in 2013 was as follows: Main scope of supply of motor gasoline and diesel fuel was implemented in the Republic of Tatarstan (respectively, 96.4% and 85.4% of the national total).

In 2013 in comparison with 2012 there was an increase in shipments of diesel fuel in the southern Federal district by 95.4%, in the Siberian Federal district by 26.4%, a significant increase in the volume of sales of residual fuel oil compared to 2012 was observed in the southern Federal district on 12.8 times more and at the North-Western Federal district by 88.6%. Sales volumes of

gasoline compared to 2012 were decreased in all regions of the Russian Federation.

In 2013 by oil refining organizations of the Republic were exported 87.1% of the total volume of residual fuel oil, 57.7% of diesel fuel and 10.3% of gasoline. In 2013 in comparison with 2012 exports of diesel fuel by 14.2%, fuel oil - by 19.4% were increased. Export supplies of motor gasoline for the same period were decreased by 20.4%.

In December of 2013 compared with November 2013 in the Republic of Tatarstan, the index of producers' prices of residual fuel oil amounted to 104%, diesel fuel - 98.1% and motor petrol - 94.7%.

In December of 2013 compared to December 2012 the index of producers' prices of motor gasoline amounted to 96.4%, fuel oil - 115% and diesel fuel - 102.3% (Figure 3).

Figure 1: The index of industrial production (in percent)

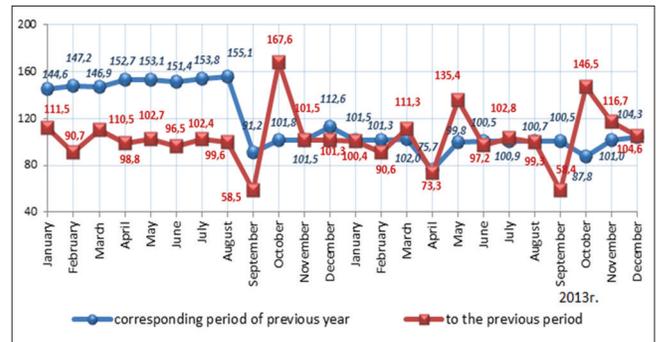


Figure 2: Growth pace (of reduction) of petrochemical shipment volumes by oil refineries to consumers (in percent)

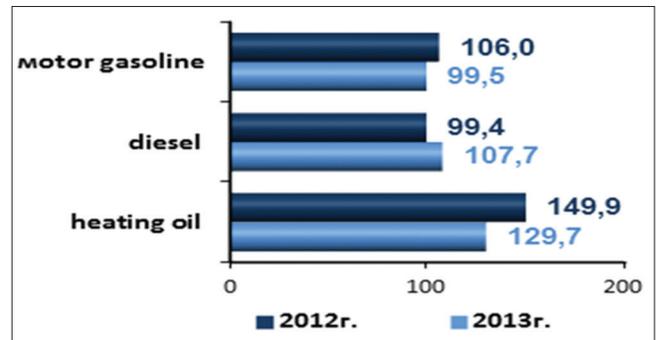
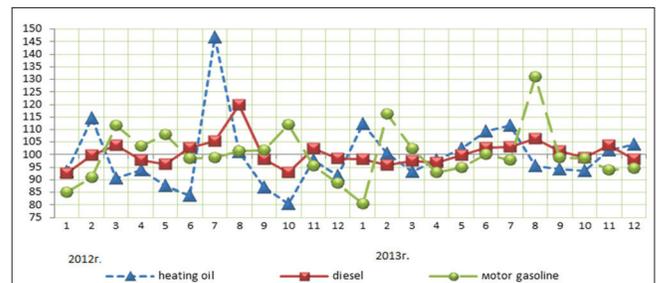


Figure 3: Dynamics of producers prices indices of petroleum products (in % to previous period)



Comparison with the regions of the Volga Federal district shows that the decrease in the producers prices' index of petroleum products in December 2013 in the Republic of Mari El was 98.46% and in the Orenburg region - 91.92%. The largest growth of the producers prices' index of petroleum products was observed in the Saratov region - 113.95% (Table 1).

The balanced financial result of large and medium-sized enterprises' activities by type of activities in "production of oil-products" in 2013 was formed positively in the amount of 13134.45 million rubles (in 2012 - positively in the amount of 15207.59 million).

The profitability of sold goods by the form of activities in "production of oil-products" was in 2013 by 11.7% being increased compared to 2012 by 0.5% points (Table2).

4. DISCUSSIONS

Thus, the strong sides of petrochemical complex of the Republic of Tatarstan from the perspective of global competitiveness are:

- Geographical diversification of exports.
- Strong export positions in the production of oil, oil products, rubbers, polymers, carbon black, tires and some other products.
- At the same time, weak sides in petrochemical complex of the Republic of Tatarstan are.
- The predominance in the exports of products of low and medium degree of repartition.

Table 1: The producers prices indices of petroleum products in regions of Privolzhsky Federal district in December 2013 (in percent to December of the previous year)

| Regions of Russia | Processing manufacture | The production of petroleum products |
|------------------------|------------------------|--------------------------------------|
| Tatarstan Republic | 101.78 | 103.41 |
| Bashkortostan Republic | 106.08 | 109.38 |
| Orenburg region | 100.64 | 91.92 |
| Nizhny Novgorod region | 104.73 | 108.65 |
| Mordovia Republic | 101.81 | - |
| Mari El Republic | 101.63 | 98.46 |
| Samara region | 103.26 | - |
| Kirov region | 103.69 | - |
| Saratov region | 98.46 | 113.95 |
| Perm region | 98.88 | 102.11 |
| Ulyanovsk region | 102.32 | 103.06 |
| Udmurt Republic | 105.77 | - |
| Penza region | 101.26 | - |
| Chuvash Republic | 100.66 | - |

Table 2: The profitability of sold goods

| Criteria | The profitability of sales by the kind of oil production activities, in percentage | |
|--------------------------------------|--|--------|
| | 2013r. | 2012r. |
| Total in the Republic | 10.7 | 11.3 |
| Processing manufacture | 7.7 | 9.6 |
| The production of petroleum products | 11.7 | 11.2 |

- High share in import of chemical and petrochemical products with high added value, as well as equipment and technologies used in this sector.

Among the major threats for the development of petrochemical complex of the Republic of Tatarstan the increased competition from the side of countries in the Persian Gulf can be noted. In particular, there is growing threat of imported products with lower cost than domestic products. Manufacturers of petrochemical products in the Middle East and China enjoy significant preferences of their governments, in the result of which their products get significant price advantages in the Russian market.

The protectionist policy strengthening of the USA, Brazil, India, Turkey, China and other countries can also lead to increased supplies to the Russian market, and thus to the weakening of domestic enterprises' position on the occupied market niche.

To opportunities of petrochemical complex's development of the Republic of Tatarstan should be referred the strengthening of positions in the chemical and petrochemical worldwide market by manufacturing of high-tech products related to the quality and range demand of the Russian and world markets, increasing of the efficiency of research and innovation activities of enterprises of petrochemical complex of the Republic of Tatarstan.

System constraints and challenges in the development petrochemical complex deal with the loss of a significant part of the potential of added value of the Republic of Tatarstan because of interruption in the "chain" of processing of hydrocarbon raw materials in its exports.

The previous researches, which were made by Mirotin et al. (2002), Meshalkin et al. (2003), Maslennikov (2007), Sergeev (2007), Mukhambetov and Bogdashkina (2013) and others are devoted to integrated supply chain.

However, the analysis of scientific works devoted to the problem of the specificity of the integrated management of supply chains of petroleum products are not investigated enough.

5. CONCLUSION

It is established that one of the weak sides of the supply chain of petroleum products is a local approach to profit optimization of each of the companies in the chain, weakly taking into account the impact on the system as a whole. However, integrated management of supply chains of petroleum products enables to eliminate many "bottlenecks". For example, if the supplier is more reliable, there is no need for additional stocks of raw materials, the quality control system, handling and other activities without added value in the result of use of lean production principles.

Improving of the supply chains' management of petroleum products requires continuous evaluation and includes change, configuration and coordination in order to improve the efficiency of the entire circuit. Therefore, the aim of integrated management is to ensure customers' maximum service at the lowest possible cost.

Supply chains of petroleum products, based on the principles of integrated logistics, should be used as an integrated and coordinated system. This will reduce costs by eliminating of unprofitable use, which “overloads” the supply chains of petroleum products. Coordination and cohesion throughout the supply chain will reduce costs that will increase the efficiency and competitiveness of the entire petrochemical complex.

In the article the content of flows’ integrated management in supply chains of petroleum products in the field of deep processing of hydrocarbon raw materials is systematized. The materials of the article are of theoretical and practical significance for the development of models of management of the integrated supply chains in the petrochemical industry.

REFERENCES

Federal State of Statistics Service. Available from: <http://www.gks.ru>.
Maslennikov, V.V. (2007), *Entrepreneurial Network in Business*. Moscow:

- Centre for Economics and Marketing. p168.
Meshalkin, V.P., Dovi, V.G., Marsanich, A. (2003), *The Strategy of Logistics Chains of Chemical Products and Sustainable Development*. Moscow: Russian University of Chemical Technology. p531.
Mirotin, L.B., Tashabiev, I.E., Poroshina, O.G. (2002), *Efficient Logistics*. Moscow: Exam. p160.
Mukhambetov, A.M., Bogdashkina, I.V. (2013), *Supply management in the oil and gas industry*. *Topical Issues of Economic Sciences*, 2, 118-120.
Sergeev, V.I. (2007), *New vision of controlling system of logistics business processes in the supply chain*. *Logistics and Supply Chain Management*, 5, 9-21.
Shinkevich, M.V., Shinkevich, A.I., Ponkratova, L.A., Klimova, N.V., Yusupova, G.F., Lushchik, I.V., Zhuravleva, T.A. (2015), *Models and technologies to manage the institutionalization of sustainable innovative development of meso-systems*. *Mediterranean Journal of Social Sciences*, 6(S2), 504-512.
The Program of Development of petrochemical complex of the Republic of Tatarstan in 2010-2014. Available from: <http://www.zakon-region3.ru/2/151505/>.