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LOGISTIC SECURITY SYSTEM OF LIQUID FUEL SUPPLY

In recent years a number of political, natural, economic, social and technological factors have contributed to the discussion about the security of supplies of crude oil and its products. There are many questions as to how a logistic security system of supply should be built to meet the requirements for effectiveness, efficiency, flexibility and continuity. Although the subject is so often discussed, it still seems to be not quite understandable and clear. This paper is an attempt to refer to this issue through a theoretical analysis of the concept and structure of the logistic security system of liquid fuels supply. The first part of the paper presents the issues pertaining to a logistic system approach, which is the starting point for a further discussion. In the second part are the basic conditions for the functioning of the crude oil market. Additionally, the subject revolves around the interpretation of the energy security term and its fundamental components. In turn, the third part leads to the identification of elements and structure of the logistic system of liquid fuels. The paper ends with considerations about the usefulness of the results for further research on the logistic security system of supplies of crude oil and its products.
Key words: logistics, system, security, crude oil, liquid fuels

1. APPROACH TO A LOGISTIC SYSTEM

The word "logistics" has its roots in ancient Greece, it comes from the Greek word logos, logikos, logistikon that is synonymous with understanding, reasoning, organizing principle, a man of fine thinking, a rational man, the forces of reason[2]. Man, since the earliest times, has always undertaken logistic activities, only their subjective, objective, or functional scope has been subject to changes. Despite this, the application of logistics in business only dates from the 1950s. At the beginning, logistics in a company served only an auxiliary function and was inferior to the main technological processes. The measures taken were merely partial and not based on a uniform concept. The next stages in the development of logistics in business were a response to the changes taking place in global markets. In industrialized countries, the position of the consumer strengthened, which shaped the size and structure of supply. At the same time the processes of political and economic integration taking place in the world have contributed to the increased pressure on time. In addition, favourable factors include the rapid development of information technology and telecommunications, substantial progress in the production of work and harmonization of standards and regulations.

In the literature of the subject there are many definitions of logistics, which have been developed depending on the knowledge and experience of the author, their main interests, or the year the definition was created. But there is no one universally applied and accepted definition of the term. In epistemological terms, logistics is an area of economic

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[2] Szymonik A., *Logistyka i zarządzanie łańcuchem dostaw*, Difin, Warszawa 2010.

knowledge, which examines the events and processes that determine the flow of material goods, people and related information in the economy. According to a subjective criterion in the logistics, the flow is considered in two formulations: narrow, within an organisational unit, and wide – across the entire supply chain (co-operating in various functional areas of mining companies, manufacturers, retailers, service providers and their clients, among which is the logistic flow). Therefore, the direction of actions in logistics is to ensure a full range of intra- and inter organizational relations. Integration has to cover four basic areas: technical and technological, legal, informational and economic-organizational. In terms of a concept, logistics is a philosophy of thinking about managing the process of movement of goods, people and information, based on a systems (overall) approach. It should be emphasized that the traditional organizational structure of enterprises has a vertical construction, while the logistic flow takes place in a horizontal space. Consequently, the decisions in individual divisions are independent from each other, which causes difficulties in the organization and coordination of tasks.

The word "system" is widely used and refers to the issues, events and objects that are seen in a comprehensive manner. Generally, it is a separate part of our reality, which constitutes a system of interrelated elements that have a specific construction and create an orderly entity according to the accepted rules. A systems approach to real events (the theory of systems) was used as early as in the 1930s. Initially popular in the biological sciences, it was later widely used in social and technical sciences as well. A systems approach is when the studied phenomena is examined wholly, not just selected components of it, and on this basis broad conclusions are formulated. It is assumed that the properties of the system as a whole are not identical with the properties that characterize its individual components. The basic principles of a systems theory[3]:

- the whole is the most important, the part plays a secondary role;
- the condition of the interrelation of parts in the whole is their integration;
- the parts play their roles in the light of the purpose for which there is a whole;
- the nature and function of the part is the result of the position it holds in its entirety;
- on the one hand, the whole is a system, on the other, it behaves as a single part;
- everything must start with a whole.

In the end, the literature is a logistic system "encompasses all human and technical means as well as methods of operation and the organizational and legal norms in their mutual functional relationship, used to optimize the movement, handling and storage of materials, together with information"[4]. Depending on research needs, one can extract various types of logistic systems. The most general, widely used division takes into account both the spatial (related to the number and type of actors) and organizational structure (including methods of organization and logistic flow management). The classification of logistic systems and their description are presented in table 1.

[3] *Logistyka*, pod red. D. Kisperskiej-Moroń, S. Krzyżaniaka, Biblioteka Logistyka, Poznań 2009.

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Table 1. The basic classification of logistic systems

Name	Description
by the institutional criterion	
• micrologistics system	internal organizational system, includes the organization of economic and administrative framework which is followed by the logistic flow
• metalogistics system	intersystem, exceeds the boundaries of individual enterprises, and thus include the interaction of several enterprises in the logistic flow
• macrologistics system	complex system, is of a general economic character, composed of many interrelated compressed systems of meta- and micrologistics which participate in a broad definition of the logistic flow
by the phase criterion	
• logistics supply system	system that operates within a wide range, from market vendors to sales market, based on an integrated approach to obtain the needed resources (raw materials, semi-finished, information, staff, etc) in sufficient quantity and quality, at given a time, place and at a right price
• logistics production system	technological process support system, includes activities that are associated with the supply of production of the necessary resources and transfer of semi-finished and finished products to distribution warehouses
• logistics distribution system	sales process support system, aimed to adjust the size and structure of offered products to its market demand, can be supplied in accordance with market needs as to quantity, quality, time, place and price
by the functional criterion	
• transport system	system for physical movement of goods and people from the point of origin to the point of destination, using appropriate technology and productive forces
• warehouse system	stockholding system with handling activities, using appropriate technologies, storage buildings, having the technical means, managed and operated by people
• stocks system	amount and structure management system of the stocks currently unused, and suitable for further processing or sale, located in the logistic system
• packaging system	system of management and service of packaging throughout its lifecycle, located in the logistic system, which realise the security, storage, transport and informational function
• customer service and order system	system of orders processing and customer service, it includes integrated management of activities using all available forms of logistic activities in order to achieve the level of customer satisfaction at the lowest possible global costs

Source: own work

2. FUEL DEMAND AND SAFETY OF ITS SUPPLY

The actual value of crude oil in the world today is the result of the strategic role it plays in the development of a given civilization. In economics, this is product described as "rare", which means that the resources available (in terms of quantity, location and time) are not sufficient to satisfy all the reported needs. This is due to man's growing needs for fuel alongside numerous limitations to access to oil [5]. On the oil market barriers to access to fuel are, on the one hand, shaped by "natural" factors, such as physicochemical characteristics of excavated material; also, petroleum is a finite and non-renewable

[5] *Monthly Oil Market Report*, Organization of the Petroleum Exporting Countries, June 2012, http://www.opec.org.

resource in “the human horizon” (current levels of stocks, taking into account the size of current consumption and the lack of a macroeconomic changes, is set at 50 years); oil reserves are located in a limited number of countries, there is a considerable discrepancy between where the greatest oil consumption occurs and the location of extraction, which is confirmed by the analysis of the data in tab. 2. and fig. 1. On the other hand, there exist the so-called artificial factors related to the size and structure of human activity. These include phenomena occurring in the further surroundings, e.g. political, legal and administrative, economic, socio-cultural and technological; they also result from the size and structure of physical, financial and human resources that are available to market participants. Because of the existing restrictions of access to oil, reported fuel needs are competing against each other. This means that in order to satisfy the given group of fuel needs one must give up on attempting to satisfy the others at the same time. Of course, with the economic, organizational or technical progress the designated boundary moves further and further away.

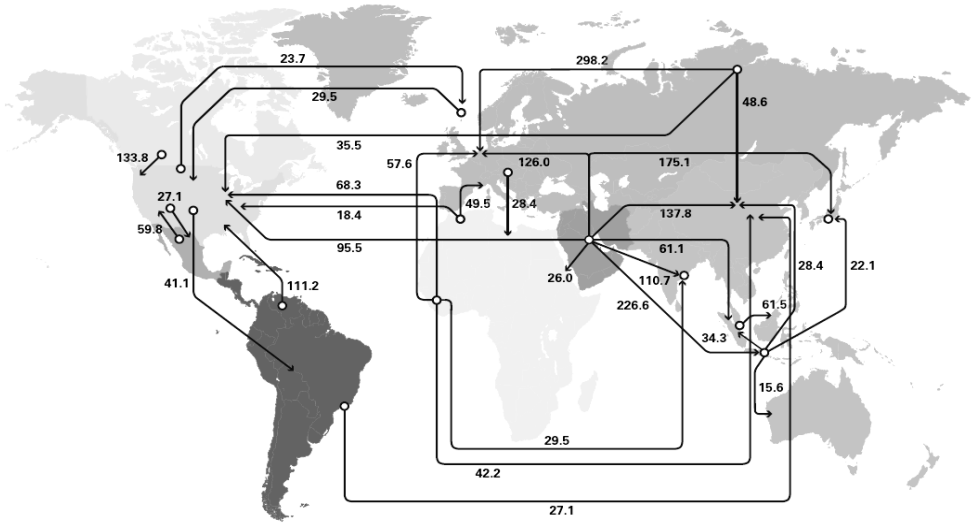
Table 2. World oil balance in 2011

Resources	billion tonnes	%	Supply	million tonnes	%	Demand	million tonnes	%
OPEC*	168,4	72,4	OPEC*	1695,9	42,4	USA	833,6	20,5
Canada	28,2	10,6	Russia	511,4	12,8	UE**	645,9	15,9
Russia	12,1	5,3	USA	352,3	8,8	China	461,8	11,4
Kazakhstan	3,9	1,8	China	203,6	5,1	Japan	201,4	5,0
USA	3,7	1,9	Canada	172,6	4,3	India	162,3	4,0
Brazil	2,2	0,9	Mexico	145,1	3,6	Russia	136,0	3,4
World	234,3	100,0	World	3995,6	100,0	World	4059,1	100,0

* OPEC - Organization of the Petroleum Exporting Countries; ** The European Union

Source: *Statistical Review of World Energy*, British Petroleum, June 2012.

Figure 1. The World oil trade trends in 2011



Source: Statistical…, *op. cit.*

Crude oil is a product directly addressed to a narrow group of customers (refineries). However, the needs for this raw material are secondary in relation to the reported needs of the society, economy and government. In other words, the final size of the demand for oil depends on the size and structure of final products[6]. Therefore, the factors determining the demand for oil products include: oil prices; economic growth and changes in its structure; income and the size and structure of household expenses; population and its age structure; geographical distribution of population; population movements; the size and scope of tourism; the size and structure of investments; the size and scope of the use of means of transport and their branch structure. In contrast, the factors that can reduce oil needs include: fluctuations and high world oil prices; changes in the structure of the transport sector; decline in population; state policy on the environment; increased efficiency in a direct and indirect oil use; development of alternative energy sources.

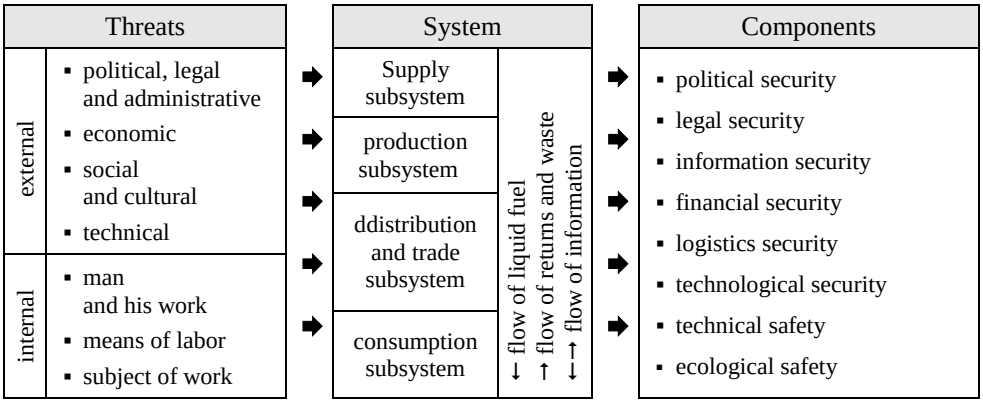
Man lives and works in the conditions of potential risks, which are activated under the influence of unfavorable changes occurring in the natural and anthropogenic environment. From the ontogenetic, social or population level, aware or unaware of the future consequences he manages the inner sphere and the environment to maintain the desired state. Safety is of interest to many in the various disciplines of science. Generally, it means the state of lack of danger, peace and confidence, or no risk of losing something that is of particular value, i.e. truth, freedom, family, life, health or work. In recent years, the global debate on energy security is the result of many factors, such as " the increase of the awareness of the world's fossil fuel energy resources, awareness of the crucial impact of energy on economic development, awareness of the impact of energy prices on the economies of countries, awareness of the bargaining power that the countries rich in energy resources possess, the escalation of more and more new threats that affect energy

[6] *Oil Market Report*, International Energy Agency, July, 2012, http://www. iea.org.

security"[7]. Therefore, ensuring energy security has become one of the main existential and developmental goals of each country [8]. According to the Polish Energy Policy Until 2025, energy security means the state of the economy which allows you to cover both the current and prospective demand for fuels and energy, would be technically and economically justified, while minimizing the negative impact of the energy sector on the environment and living conditions of the society[9].

Taking the subject criterion into account, one of the important areas of energy security is the security of liquid fuels supply (crude oil and its products). In literature, there exists a lack of unanimity in the understanding of this concept and its scope. For example, the concept is perceived in one way by oil suppliers, and in yet another by their customers. In this paper, the security of liquid fuel supply means a guarantee of optimal (best, most beneficial, the most favorable) oil supplies and its products at a level that guarantees the satisfaction of current and future needs, at prices acceptable by the society and the economy. The main postulate is the reliability of supply (the guarantee as to quality, amounts of, place and time) and price (guarantees good relations between the inputs and the outputs of the system). The actions taken cannot be a single act (security is not achieved on a permanent basis), they should cover the whole supply chain for mining, processing, trade and the flow of liquid fuel together with the information in the enterprise and between the cooperating enterprises. The division of responsibilities for safety include central and local administration, logistics, mining and processing enterprises of oil and the end clients. As a consequence, the security of liquid fuels supply operates as part of a complex body of a political, social, environmental or economic nature. The test of its division into components is shown in fig. 2.

Figure 2. System security of the liquid fuels supply



Source: own work

[7] *Energia w czasach kryzysu*, red. K. Kuciński, Difin, Warszawa 2006, s. 128.

[8] Yergin D., *Ensuring Energy Security*. Foreign Affairs. Vol 85. No. 2, 2006, s. 69-82.

[9] *Polityka energetyczna Polski do 2025 roku*, Ministerstwo Gospodarki, Warszawa 2005.

3. STRUCTURE OF THE LIQUID FUELS LOGISTICS

One of the basic components of security supply of liquid fuels is their safety logistics. A liquid fuels logistics system is a targeted system, extracted from the environment, having an internal structure consisting of parts (i.e. the components of physical and abstract parts) arranged according to accepted standards and regulations (both internal and external). It is a metalogistic system (exceeds the boundaries of individual companies), the space-time transformation of crude oil and its products, whose main objective is to provide an optimal flow of information in the enterprise and across the supply chain. For the purposes of legal, economic, organizational and technical analysis the logistic system should be considered in terms of a tangible, subjective and functional approach.

In a tangible approach, a logistic system of liquid fuels supply is determined on the basis of its physical equipment (i.e. means of labour). Means of labour are tools that directly or indirectly affect the subject of work (crude oil and its products) and are necessary to perform the tasks in the handling, storage or movement of the object of labor. These include logistics infrastructure (a group of linear and point objects permanently connected with space) and suprastructure logistics (rolling stock and equipment, and technical measures that are most often moving). It should be noted that the means of labour may be of a mutually complementary character - they complement each other; the use of a measure of labour determines the use of another, or of a substitutional character – which is the possibility of replacing a means of labour with another for the same purpose, with a similar effort.

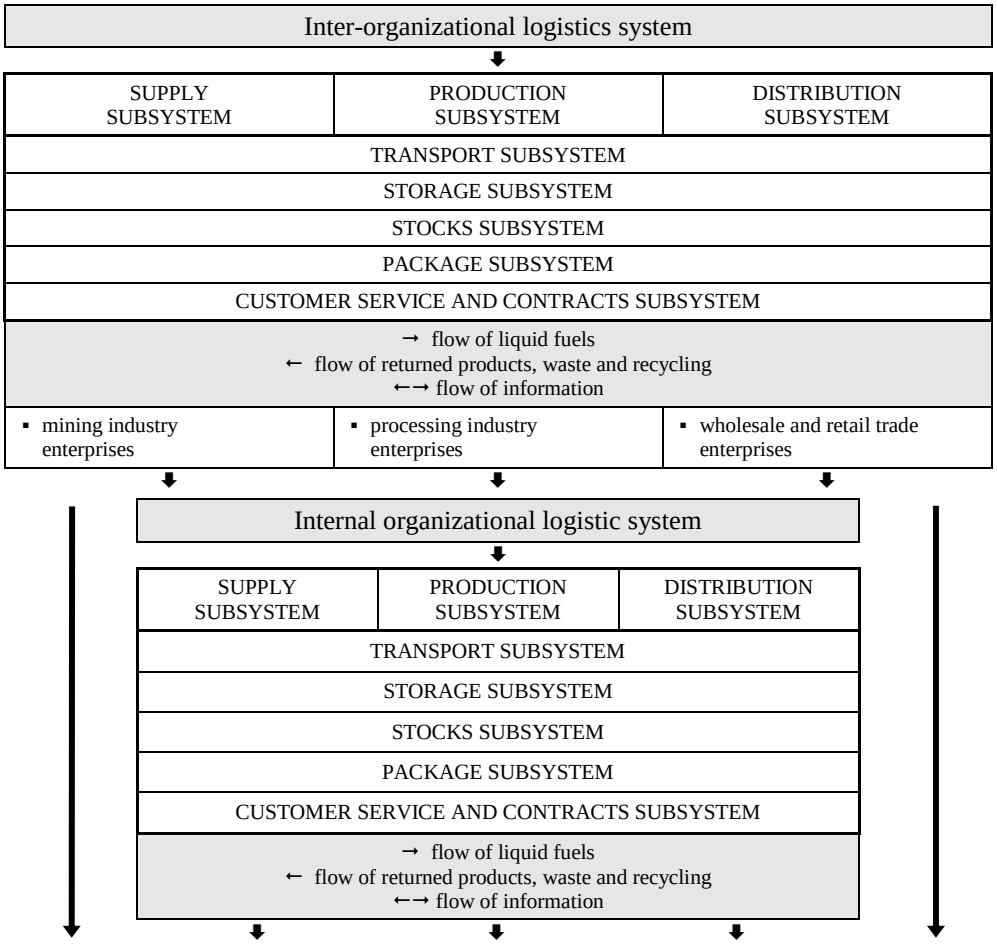
In a functional approach, a logistic system is a liquid fuel production process to ensure the flow of liquid fuels, including the information in the enterprise and between cooperating enterprises, using the appropriate production forces (means of labour, and the man and his work). The system understood in this way includes both the physical flows sphere and the regulatory sphere. The sphere of physical movement can be considered in two approaches. On the one hand, adopting the phase criteria we distinguish the supply, production and distribution logistics subsystem. On the other, using the criterion of functional logistics subsystem we distinguish: transport, storage, inventory, packaging, customer service and contracts. However, the regulatory domain is a complex process of planning, organizing and control of logistic activities carried out to ensure the smooth and efficient flow of materials, intermediates and final products.

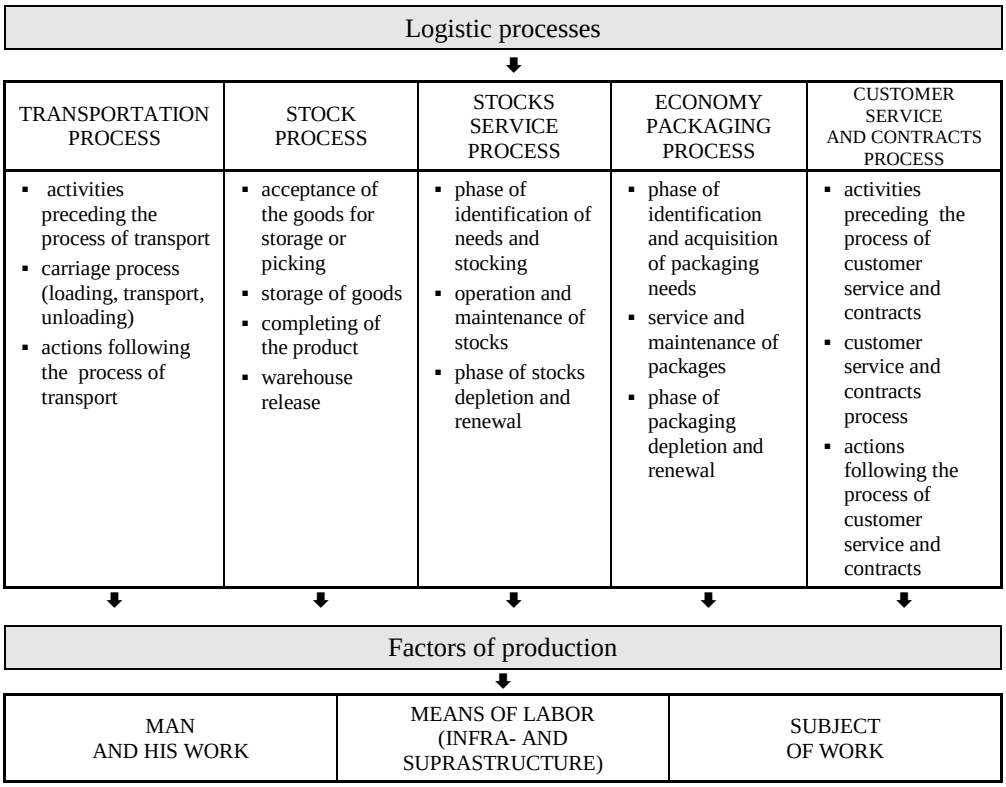
In a subject approach, a liquid fuels logistics system is a purposeful flow of liquid fuels together with information, technically, organizationally and economically separated from other activities. Technical separation means the use of the means of labour to carry out work of logistic processes. Organizational separation is related to the creation and operation of an entity that has a specific location, internal structure, and employees. Economic separation allows for a financial analysis and evaluation of carried out logistic projects. In this perspective, the structure of the logistic system is presented as a network of co-operating organizational units in various functional areas. The management of a logistic system can be done in two ways. The first is at the level of the specified organizational unit (so-called micrologistic system management) is planning, organizing, leading and controlling the work of teams of human resources and means of labour to achieve long-term objectives in the most effective manner, i.e. according to the rules of economic rationality. The second one occurs at the level of the entire logistic system for liquid fuels (so-called metalogistic system management). Within the entire system there

may be conditions favourable for perfect or imperfect (monopolistic and oligopolistic) competition or for a monopoly. At this stage, currently there is a discussion going on as to whether the system should be designed and managed, either directly (capital control of the subjects) or indirectly (standards and regulations) by the central unit (e.g. the state), or formed exclusively by fundamental factors (i.e. demand, supply, price, etc.).

In conclusion, the concept of the logistic security of liquid fuels supply is a multifaceted issue, and so many different and sometimes incomparable factors must be taken into account. Therefore, the analysis of the liquid fuels logistics system in a tangible subjective and functional approach allows us to know the description of the basic elements of the logistics system and its structure. The end result of the analysis is the proposed model of the logistic system of liquid fuels, which is shown in fig. 3.

Figure 3. Logistic model system for liquid fuels





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4. CONCLUSIONS

The logistics security system of liquid fuels supply should be considered both as part of a broader system, as well as a set of interrelated elements of a lower level. It should be emphasized that a holistic approach to all of the logistics processes leads to the understanding of the relationship between the individual elements and the assessment of their impact on the efficiency and effectiveness of the system. Because of complexity of the individual subsystems and bearing in mind the changes taking place in the environment (uncertainty), the analysis of the logistic security system of liquid fuels supply should be carried out simultaneously in a tangible, functional and subjective approach. A useful tool for the analysis presented is the proposed structure of liquid fuels logistic system.

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LOGISTYCZNY SYSTEM BEZPIECZEŃSTWA DOSTAW PALIW PŁYNNYCH

W ostatnich latach liczba czynników politycznych, przyrodniczych, ekonomicznych, społecznych i technologicznych przyczyniła się do dyskusji na temat bezpieczeństwa dostaw ropy naftowej i jej produktów. Istnieje wiele pytań, jak powinno być tworzone logistyczne bezpieczeństwo systemu dostaw w celu spełnienia wymagań w zakresie skuteczności, efektywności, elastyczności i ciągłości. Chociaż temat ten jest tak często omawiany, to nadal wydaje się być nie do końca zrozumiały i jasny. Niniejszy artykuł jest próbą odniesienia się do tej kwestii poprzez teoretyczną analizę pojęcia i struktury systemu logistycznego w celu zabezpieczenia dostaw paliw płynnych. W pierwszej części artykułu przedstawiono zagadnienia dotyczące logistycznego podejścia systemowego, który jest punktem wyjścia do dalszej dyskusji. W drugiej częściomówiono podstawowe warunki funkcjonowania rynku ropy.Kolejna część dotyczyła interpretacji pojęcia bezpieczeństwa energetycznego i jego podstawowych składników. Z kolei trzecia część prowadzi do identyfikacji elementów i struktury systemu logistycznego paliw płynnych. Artykuł kończy się uwagami na temat przydatności wyników dalszych badań nad systemem logistycznego zabezpieczenia dostaw ropy naftoweji jej produktów.

Słowa kluczowe: logistyka, systemy, bezpieczeństwo, ropa naftowa, paliwa płynne

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