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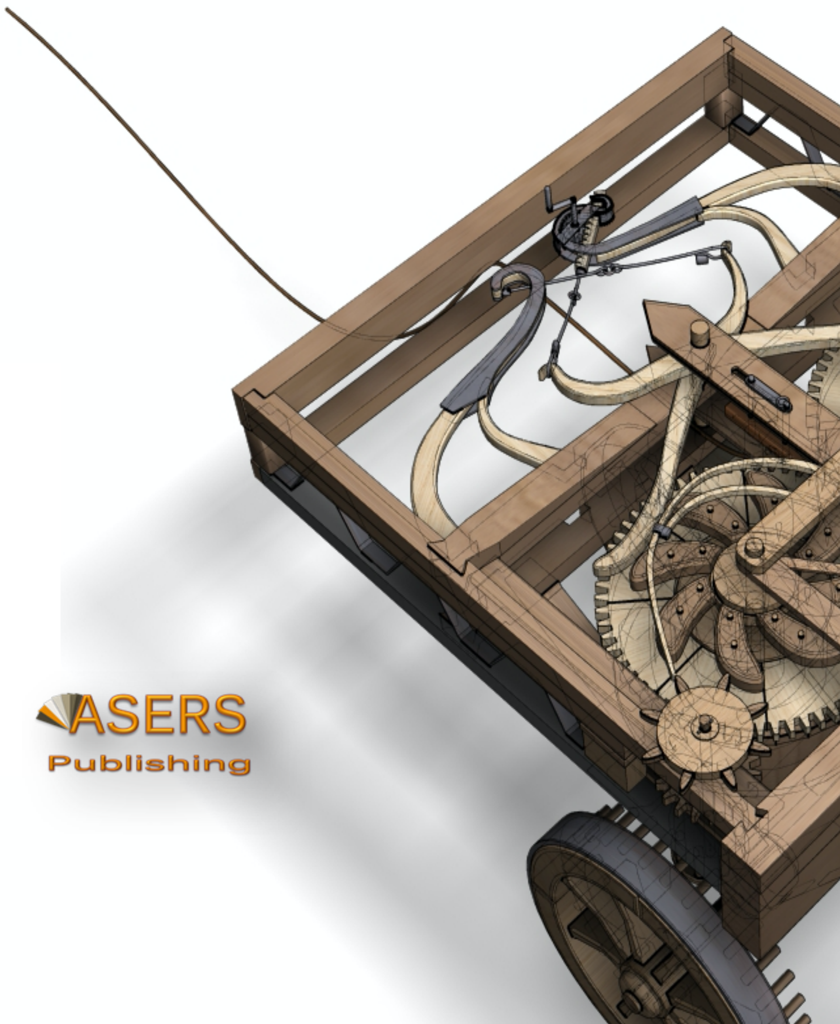

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Table of Contents:

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Organization of the System of Internal Marketing and Marketing of Interaction of Agricultural Enterprises for the Production of Biodiesel Based on Value Chain Analysis

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Abstract:

The aim of the study was to analyze and evaluate the organization of the system of internal marketing and marketing interaction of agricultural enterprises for the production of biodiesel based on value chain analysis.

The authors conducted a research on the formation of a marketing model and the corresponding marketing policy of the enterprise, where it is methodologically important is the formation of effective value chains as a basis for competition in the market. The theoretical approach to the formation of the value chain within the marketing model of an individual agricultural enterprise is substantiated. At the same time, value chains are seen as production networks in which businesses use competitive resources and operate in an institutional environment, and form network of horizontally and vertically connected enterprises united by a partnership model of interaction.

The objectives of the study were solved using such methods as: historical, systematic, inductive and deductive, analysis and synthesis, modeling and comparative analysis.

To ensure the efficiency of energy production from biomass, the optimality of the logistics factor should be ensured. Applied models based on tools such as operations research and mathematical optimization using computer algorithms have been developed to plan and manage biomass supply chains.

It is proposed to model supply chains and / or create value by types of resource flows with the possibility of their modular connection to the overall model, which, in our opinion, can increase the reliability of the results.

To study the value chain of biodiesel in Ukraine, an appropriate model was developed to simulate the flow of raw sunflower and rapeseed, as the use of both crops was identified as the most common for biodiesel production in Ukraine. The model differs from the existing ones in that it takes into account different scenarios to determine the total cost of biodiesel production, as well as the cost of individual activities in the value chain formation.

Keywords: value chain, biodiesel, diesel flow, internal marketing system, interaction marketing.

JEL Classification: O13; Q49.

Introduction

Biofuels have significant potential to create a resource-efficient, competitive, and low-carbon market since they are renewable energy sources and do not emit large amounts of carbon into the atmosphere, like traditional fossil fuels such as oil and coal. Biofuels can also be produced in local farms, reducing the dependence on imported fuels (Bennich, Belyazid, Kopainsky and Diemer 2018). There is an urgent need to foster novel biofuel value chains that can deliver on environmental sustainability, resource efficiency and economic competitiveness, in connection with with a continuously growing stock of global atmospheric carbon and renewed political commitments for net zero carbon solutions by 2050 (NASA. Available online: https://climate.nasa.gov/evidence). Fostering novel biofuel value chains that can deliver on environmental sustainability, resource efficiency, and economic competitiveness is essential to meet the urgent need for net zero carbon solutions and to transition to a more sustainable and low-carbon energy system. System dynamics modeling is used to analyze and map the functioning of multi-sector integrated value chains in which different sectors of the economy interact with each other to provide a map of all input-output interactions (Giannopoulos 2022, 509-532), and refinement of assumptions allows to take into account a variety of factors and variables that can affect the studied system, which helps to increase the accuracy of forecasts and estimates (Hoffman, 189-212).

The conflicting content of the modern development of agricultural enterprises in Ukraine is due to two main trends: on the one hand, the process of adaptation of the industry to market conditions continues, taking into account dysfunctions and barriers to transformational constraints, and on the other - globalization and post-industrial factors such as ecological requirements, in particular the energy component of production. This characterizes the state of agricultural enterprises specializing in the production of biofuels. At the same time, the main management schemes of effective business management that update the research, among them the issues of marketing of this group of enterprises, remain undeveloped.

Research on the problems associated with the formation of the system of internal marketing and marketing interaction of agricultural enterprises for the production of biodiesel remains highly relevant and needs to be developed primarily in the context of studying the determinants of the marketing environment of this business and market.

1. Literature Review

Various market subjects pursue sustainability and efficiency goals in isolation and neglect interactions than can bring opportunities or help overcome challenges pursue sustainability and efficiency goals in isolation and neglect interactions than can bring opportunities or help overcome challenges (Singh, Christensen and Panoutsou 2020). Scientific research on the production and use of biofuels or bio-based value chain literature spans many studies seeking to harmonise sustainability and performance dimensions, with some innovative modelling techniques. Roni M.S., Eksioglu S.D. (2017) use mixed methods and multi-objective optimisation to measure trade-offs within biofuel production between costs and environmental impacts, but Sarkar B., Mridha B., Pareek, S. (2021) appreciated the production of biofuel taking both carbon emissions and energy use into consideration through an advanced biofuel supply framework, including value chain costs, biofuel demand and market price.

In turn Sarkar M., Mridha B., Garai, A., Chowdhury S., Karka, P. and other researchers (Sarkar *et al.* 2021; Garai, Chowdhury, Sarkar and Roy 2020; Karka, Johnsson and Papadokonstantakis 2021) employed interactive multi-objective closed-loop value chain models to equip decision makers with tools to optimise the inter-relation of financial and operational assets along biomass value chains. These studies aim to apply advanced biofuel value chain analysis through a deterministic, stock-and-flow system dynamics model to analyse both quantitative technical, operational and environmental factors, and later define these through competitive priorities.

However, in scientific research there has been less emphasis in system dynamics literature on incorporating logistical operations and individual value chain variables to support the roll-out of biomass as a source of energy, which may be due to a data availability issue (Ramos-Hernández, *et al.* 2021). Musango J.K., Brent A.C. and other created established a multi-layered model to determine the potential impact of biodiesel technological and supply chain development on sustainability (Musango *et al.* 2011). Christensen T. and Panoutsou C. stock-and-flow model is developed to map a full biofuel value chain and quantitatively and coherently integrate factors of emissions, carbon, land, production, and technology (Christensen and Panoutsou 2022). In turn Vimmerstedt L., Bush B.W. combined key sectors of the biofuels industry, including each value chain stage to study biomass-to-energy technology and cost pathways (Vimmerstedt, *et al.* 2014). Bautista S.; Espinoza A., Narvaez P. (2019) modeled the impacts of government intervention, biodiesel-diesel ratio, production capacity, oil palm cultivation, population displacement, poverty and pollutant emissions on biodiesel production. Kuo T.C. (2019) and other assessed the potential of biofuel commercialisation through both market and value chain factors.

The research of these scientists covered some issues of theoretical and methodological provisions and practical recommendations for the formation of marketing policy of agricultural enterprises for the production of biofuels, analysis of world experience and the possibility of its use in the domestic agricultural sector.

The purpose of this study is to organize the system of internal marketing and marketing interaction of agricultural enterprises for the production of biodiesel.

2. Methodology

The theoretical and methodological basis of the study are the fundamental conclusions, provisions, concepts and hypotheses set out in the works of foreign and domestic scientists on domestic marketing and marketing interaction of agricultural enterprises for biodiesel production in modern market conditions. In the process of the study, the authors tried to adhere strictly to the principles of historicism and objectivity, which were the main worldviews when considering any of the issues raised. Both of these principles are in dialectical unity, as if complementary and at the same time inextricably linked with dialectics.

The objectives of the study were solved using such methods as: historical, systematic, inductive and deductive, analysis and synthesis, modeling and comparative analysis.

Methodology and general scientific principles of complex economic research formed the basis of the study, the fundamental provisions of modern economic theory, the conceptual foundations of marketing theory and marketing policy in the management of agricultural enterprises in the biofuels market, research, position and development of leading domestic and foreign experts. In addition, general scientific methods of empirical and theoretical research based on dialectical and systemic approaches were used.

In addition to a number of general scientific methods of economic research, the historical method (to describe the retrospective of the process of value chain formation) and logical (to determine the meaningful sequence of the process of value chain formation in the biofuels market in Ukraine) method of cognition was used.

The author's methodology was based on the concept of organizational management, which was formed on the determinism of the role of marketing policy factors, certain aspects of production activities, supply chains and value creation, quality management of raw materials and products; as a theoretical basis of research the classical theory of marketing, in particular agro-marketing management, theories of competition, new institutional economy, marketing activity of the agricultural enterprise of post-industrial type was used.

Conceptualization of the marketing policy of an agricultural enterprise for the production of biofuels was carried out on the basis of the theory of corporate governance and social responsibility, as well as a theoretical approach to the formation of value chains and market interaction, social networks, marketing analysis and others.

3. Case Studies

Globalization and the development of international markets, as well as growing middle- and high-income classes in many developing countries, enable producers to operate in new national and international markets. This means that producers must perform better control over production, trade and distribution to ensure the appropriate level of quality and added value of their products. In addition, manufacturers must adapt to strict quality and safety standards in new markets.

At the same time, important barriers for agricultural producers in forming their own marketing model are the lack of a favorable environment that can provide institutional and infrastructural support, availability of resources, productive and effective coordination in creating added value (Logosha, Moroz, Semenyshena and Chykurkova 2019, 172-194). In particular, small producers are at a disadvantageous situation because they do not have enough capital to invest, use traditional technologies, depend on the labor force of family members and have no contact with international market participants (Honcharuk, Furman and Dmytryk 2022, 7-20). The scientific literature describes many cases of small farmers looking for new forms of cooperation to improve their position in the value chain. This necessitates the study of chain theory, value creation in the formation of a marketing model in the field of agriculture as a way to justify the interaction of enterprises.

Global value chains are characterized by falling barriers to international trade due to lower tariffs, lower price support and export subsidies in recent decades. At the same time, there is an increase in concentration and consolidation in all parts of these chains. In addition, achievements in communication technologies and reducing transport costs contribute to improved coordination between chain participants (Kaletnik, Honcharuk and Okhota 2020, 513-522) not through vertical integration, but through the standardization of processes and the use of complex information and communication technologies, which means the growth of integration of world markets and is intensified by the collapse of multinational firms (Kaletnik and Lutkovska 2020, 1124-1131). Those producers in developing countries who want to enter value chains face asymmetric power in the relationship (for example, due to increased global power of Western retailers and relevant industries), which affects the distribution of costs and benefits for chain participants, leaving the activities of adding value in Western countries.

However, value chains can also be seen as a means of introducing new forms of production, technology, logistics, labor processes, organizational relationships and connections. There are more and more small production and distribution networks, and suppliers of developing countries are able to capture their own share of research and complex production processes (Ivarsson and Alvstam 2005, 1325-1344). Therefore, the formation of the marketing model of an agricultural enterprise should be carried out in the context of the analysis of the value chain of products and services.

While designing a marketing model, an important problem for manufacturers is how to enter value chains and how to improve in order to compete in new markets. Therefore, the important issues that need to be addressed are: increasing the efficiency and increasing the added value of products manufactured by manufacturers in cooperation with entities in value chains and the coverage of new market opportunities; ways, methods, means of optimal use of the business environment, in which international value chains are built (domestic and local economic, legal, socio-cultural environment); identifying key upgrades and the most appropriate entities to upgrade the value chain.

Modern literature does not offer a comprehensive approach to addressing these issues, and also demonstrates the lack of approaches to identify key elements of a comprehensive study of value chains in the formation of a marketing model in agriculture. Therefore, in this paper we offer an approach for the formation of a marketing model based on the analysis of value chains formation. Based on the given above approach, a model of marketing interaction of agricultural enterprises for biofuel production will be developed. The main object of the study will be the economic activity of agricultural enterprises.

The main purpose of the value chain is to produce value-added products or services for supply to the market by transforming resources and using infrastructure within the capabilities and constraints of the institutional environment. Therefore, in our opinion, the limitations for the development of the value chain are related to the following factors: market access (local, regional, international) and market orientation (for example, Grunert *et al. 2005*, 429-455); available resources and physical infrastructure (Porter: factor conditions) (Porter 1990); activities of institutions (regulatory, cognitive and regulatory, Scott 1995).

During the last decades there is a holistic theory of building value chains (Lazzarini, Chaddad and Cook 2001, 7-22), reflected in many definitions and analytical approaches. The term «value chain» was first used by M. Porter in the 1970s and 1980s and reflected the nature of business processes for adding value within the enterprise. Scientific disciplines that complement the development of value chain theory can be grouped into four theoretical approaches, characterized by different views on the establishment of links between enterprises, as shown in Fig.1:

(1) the analysis of the global value chain focuses on the position of the leading enterprise in value chains and power relations between producers in developing countries and Western markets or multinational companies (MNCs);

(2) social network theory focuses on the relationship between economic and social relationships in production networks, which consist of many horizontal and vertical relationships between entities in the value chain;

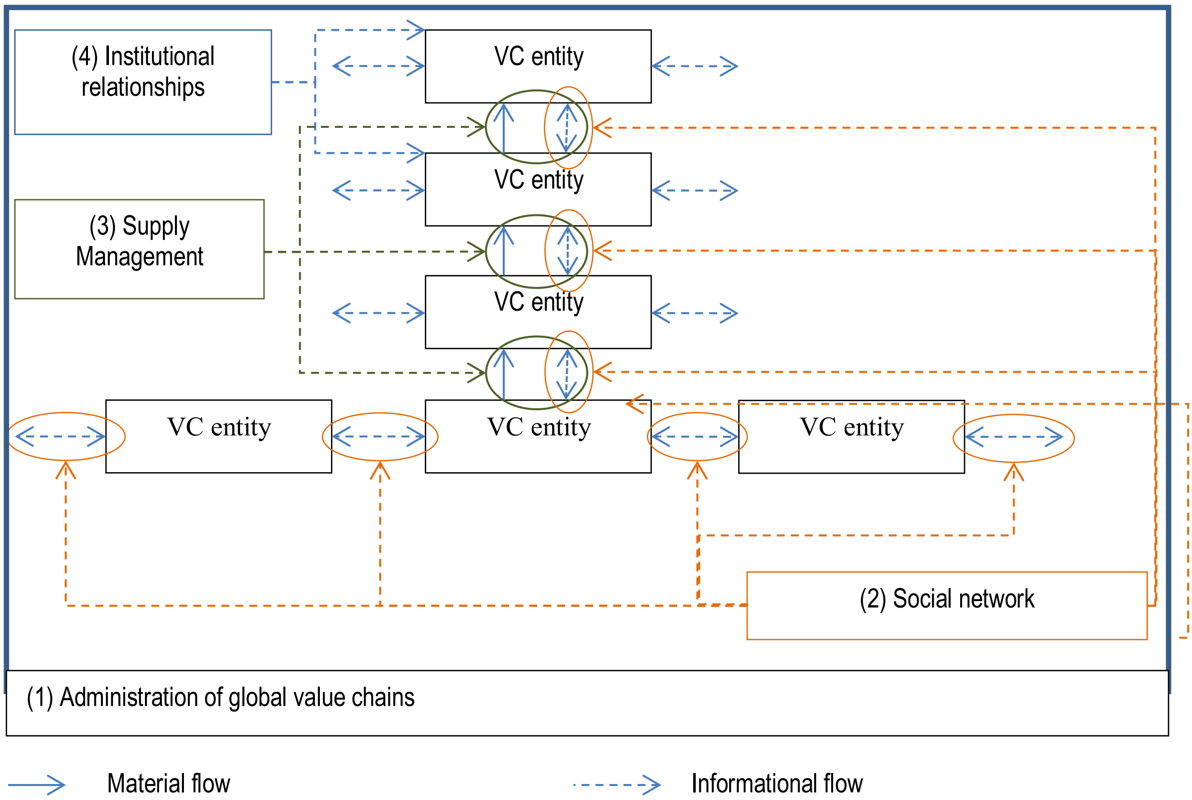
(3) supply chain management studies the management and control of intersectoral transactions (flows of goods and services);

(4) the new institutional economy studies the management / organization of transactional transactions between enterprises.

The analysis of global value chains is based on the approach of product chain analysis (Gereffi 1999, 37-70) and explores the relationships between multinational companies, «leading companies» and other participants in international value chains. In the theoretical approach to the analysis of global value chains, power distribution, power relations and information asymmetry are key concepts. Also in Kaplinsky (2001, 117-146) the value chain is considered as a repository of rent. Rent arises due to inequality of access to resources (barriers to entry according to M. Porter 1990), lack of resources and differences in the productivity of factors of production, including knowledge and skills. Economic rent is dynamic in nature. Nadvy K. shows that employment and income have a positive effect on the inclusion of enterprises in global value chains formation, in particular, in those where the entities are transnational corporations (Nadvi 2004, 20-30). At the same time, workers in global value chains are becoming more sensitive to changes in employment contracts and the randomness of work.

The scientific literature that highlights the results of research into the management of operations in value chains is supply chain management. Supply chain management as a theoretical approach to value creation appeared in the logistics literature in the 1980s and initially focused on logistics planning and inventory optimization throughout the supply chain. Supply chain management is customer-oriented, *i.e.* customer demand is a leading concept in this approach, and aims to integrate business planning and balancing supply and demand throughout the supply chain from the primary producer to the final customer / consumer (Bowersox and Closs 1996; Cooper, Lambert and Pagh 1997, 1-14). Information and communication systems are considered to be the basis of evenly operating supply chains. Both approaches, the supply chain and the value chain formation, focus on the primary processes, *i.e.* the processes of transformation and transaction through vertically connected enterprises. The supply chain mechanism focuses on process improvement, quality assurance and distribution optimization. For example, in the food industry, much research has been devoted to integrated quality management systems (Francis, Simmons and Bourlakis 2008, 83-91).

Figure 1. Theoretical approaches to the study of the relationship of enterprises in the theory of the value chain in building a model of enterprise marketing



Source: compiled by the author on the basis of Lazzarini, Chaddad and Cook 2001, 7-22

The new institutional economics, with units such as transaction cost economics and organizational theory, explores ways to justify management decisions in the organization and internal organizational relations. In the economics of transaction costs, a key element of the analysis are transactions between enterprises (Rindfleisch and Heide 1997, 30 - 54; Williamson 1999, 1087-1108). Businesses choose a form of management that minimizes transaction costs, in conditions of limited rationality and opportunistic behavior of partners. The entities in the value chain prevent opportunistic risks through joint investments, monitoring systems and specific organizational arrangements. According to K. Eisengart (1989, 57-74), in the theory of organization, one entity delegates work to another, who performs this work. In other words, the theory of organization determines management decisions when evaluating the output of the supplier/agent (when transferring risk to the agent) and evaluating the behavior / processes of the agent (transfer of risk to the lead agent). The new institutional economy is increasingly used in determining the best contract for producers in an uncertain business environment with opportunistic behavior of participants and a weak institutional regime (Porter1990).

The theoretical approach of social networks considers enterprises as entities embedded in a complex of horizontal, vertical and business support relationships with other enterprises and organizations that provide resource support and provide services (*e.g.,* consulting services, lenders and transport companies). According to network theory, relationships are formed not only on the basis of economic considerations, but also other concepts such as trust, reputation and power, which also have a key impact on the structure and duration of relationships between enterprises (Uzzi 1997, 35-67). Since the 1990s, the theory of social capital has become an important unit within the theory of social networks. Network relations can increase the «social capital» of the enterprise, facilitating access to information, technical know-how and financial support (Myronenko, Polova, Prylutskyi and Smoglo 2017, 243-253) and encouraging the transfer of knowledge between partners in the network (Humphrey and Schmitz 2002, 1017-1027) thereby reducing transaction costs and improving access to markets (Gulati 1998, 293-317). Much of the scientific literature is devoted to regional clusters, where intra-cluster vertical and horizontal relationships are considered as sources of support for the efficiency and productivity of business networks (Giuliani, Pietrobelli and Rabellotti 2005, 549-574).

In the context of the new institutional economy, social network theorists argue that trust, reputation and interdependence suppress opportunistic behavior, which means that inter-entrepreneurial relations are more complex than the new institutional economy (Kaletnik and Lutkovska 2020, 1124-1131).

According to the existing theoretical approaches to the formation of the value chain, below we offer a theoretical approach to the analysis of the value chain in the formation of the marketing model of the agricultural enterprise.

Value chains will be seen as production networks in which businesses use competitive resources and operate in an institutional environment. Therefore, a value chain is a network of horizontally and vertically connected enterprises that jointly focus on work or perform work to provide the market with products or services. Based on the classification of R. Ruben and others (2007) we characterize the value chain by its network structure, method of adding value and form of management, and also propose to determine the marketing complex that can be used by enterprises of the value chain to overcome market constraints:

Network structure: based on supply chain management approaches and network theory, we depict the network structure of the value chain, including the market (local, regional, international). Supply chain management focuses on the vertical links between economic operators who seek to jointly produce products needed by the market. Network theory substantiates the horizontal and vertical relationships between entities.

Added value: based on the approaches of supply chain management, the new institutional economy and value chain analysis, we justify the creation of added value. Supply chain management focuses on how value is created throughout the chain (value added can be created by improving quality, reducing costs, reducing delivery time, etc.). The new institutional economy and, in particular, the economics of transaction costs focus on transaction costs. Value chain theory substantiates the sources of value added in the chain.

Form of management: on the basis of the new institutional economy, value chain theory and network theory, it is possible to substantiate the positions of administration and negotiating positions of the subjects of the value chain and the corresponding distribution of value added. The new institutional economy explores the optimal governance structure between economic entities. Value chain theory substantiates the structure of chain management. Network theory focuses on formal and informal management of horizontal and vertical relations.

Marketing complex: on the basis of marketing theory it is possible to substantiate the methods and tools of analysis, to establish the potential to increase competitiveness, to design products with a focus on market requirements and to link product characteristics with production characteristics. Marketing theory also substantiates the ways and means of establishing market interaction between the subjects of the value chain in terms of their market orientation.

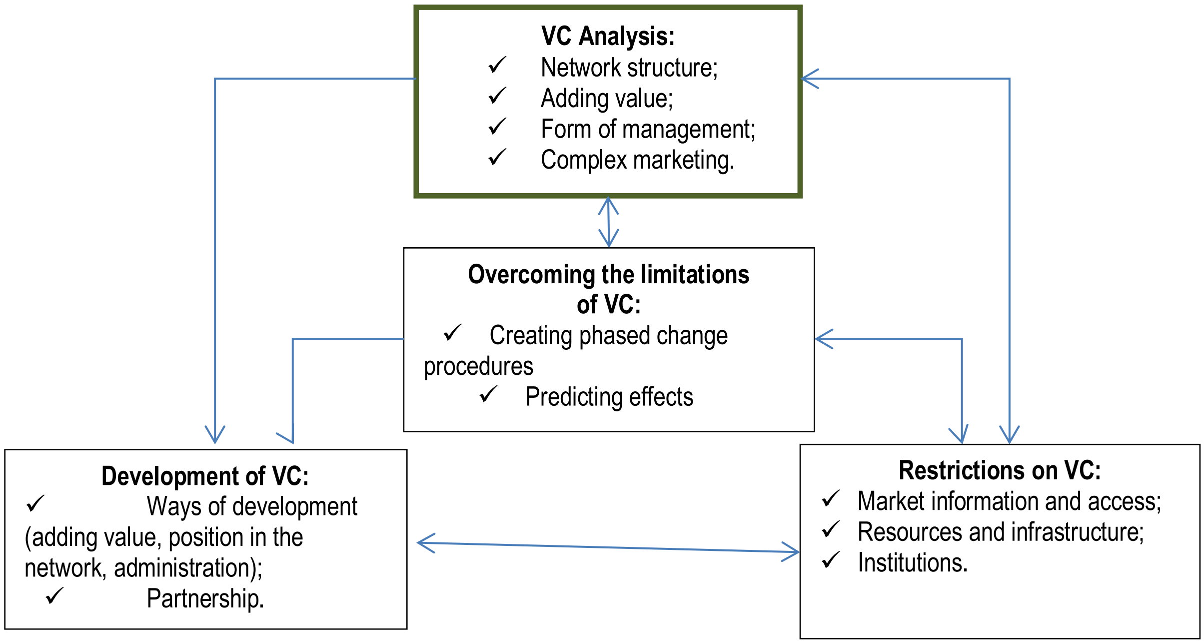
Changes in the institutional environment or the competitive environment, or in the infrastructure and availability of resources, can create alternatives to the functioning and performance of value chains, thus creating major constraints to value chain development and creating possible ways to overcome them. Value chain entities can be motivated to improve their position in the value chain by using a marketing mix by engaging in another market channel, by improving the quality and terms of supply, or by reducing costs by reorganizing collaboration with value chain partners.

Fig. 2 shows the proposed algorithm for the formation and evaluation of a marketing model based on the analysis of the value chain (VC) in General.

The network structure has two dimensions: vertical and horizontal. The vertical dimension reflects the flow of products and services from the primary producer to the final consumer (*i.e.* the value chain or supply chain). The horizontal dimension reflects the relationships between entities in the same chain (between agricultural enterprises (farmers), between processors, between intermediaries, etc.). S. Lazarini and others (2001, 7-22) developed the concept of a network chain to show the relationship between horizontal and vertical measurements of value chains.

Vertical relationships are formed between different links in the value chain and horizontal links between entities in the same chain. Vertical relationships can follow all stages of value creation or can skip individual links in a chain, such as relationships between wholesalers and retailers. Horizontal relationships between entities can also take various forms, such as farmers' cooperatives or pricing agreements between sales representatives. The structure of the network largely depends on the market channel chosen by the various entities. A marketing channel connects producers and the market, and can be defined as a value chain or supply chain that forms a «channel» for goods and services intended for sale in a particular market.

Figure 2. Algorithm for forming and evaluating a marketing model based on value chain analysis



Source: compiled by the authors

The position of the enterprise in the market channel depends on the following key decisions (Stern, El-Ansary and Coughlan1996): the choice of products or services and markets; ensuring compliance of the internal characteristics of the product or service and the external characteristics of the production process; choice of distribution strategy (single-channel or multi-channel strategy); setting the number of links in the distribution channel.

The choice of channels is limited by the resources to provide access to markets, such as supporting infrastructure, access to demand and price information, and specific market quality requirements. In addition, the ability of enterprises to participate in market channels is closely linked to the characteristics of these markets, knowledge of the market needs of the manufacturer and its technological capabilities. Grunert K. proved that the more homogeneous and dynamic the supply of raw materials to the value chain, the more market-oriented measures can be expected at its highest levels.

Conversely, from the point of view of the final consumer, the degree of heterogeneity and dynamism of the final consumer markets is a determining factor in the degree of market orientation of the chain (Lohosha and Semchuk 2021, 175-187).

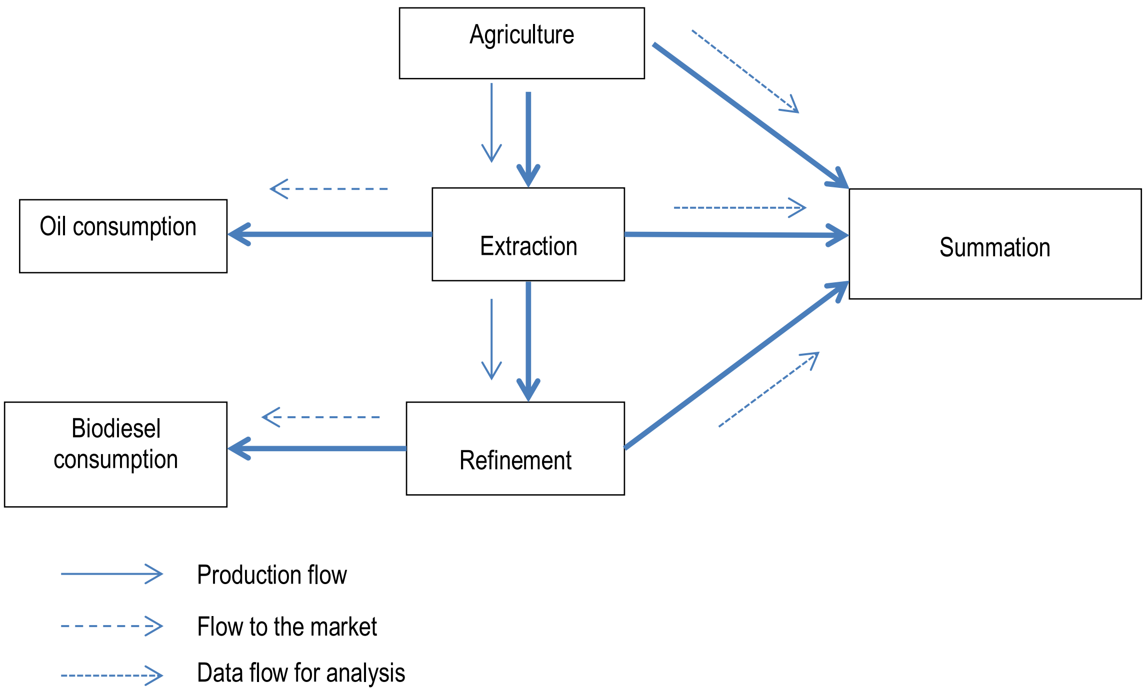
Market channels vertically structure the value chain or network. The horizontal dimension is formed by purchasing, production and supply relationships between entities that are located in the same value chains, such as supply or marketing cooperatives, or cooperation agreements between small and medium-sized processors. Then market access, market information and information exchange through vertical links of the value chain, as well as control over quality standards, can be provided through horizontal cooperation and information exchange, through knowledge transfer and joint investment in ancillary systems (Pronko, Kolesnyk and Samborska 2020, 243-252).

The structure of the value chain is dynamic. Globalization has led to the formation of clear supply, production and distribution networks in all sectors of the economy around the world. For example, G. Gereffy (1999, 37-70) showed how the global network of suppliers has evolved from links between low-cost Asian manufacturers and Western value-added manufacturers to links between Western brand manufacturers and Asian value-added manufacturers. In addition, in the food industry, differentiation has led to further specialized distribution and sales around the world (Logosha 2020, 1-7). World experience shows that factors such as international norms and legislation also have a significant impact on the formation of supply chains. Kaletnik G. (2020, 513-522) demonstrated the important role of international trade rules in the formation of international distribution structures.

We investigated the targeted use of by-products formed in the biodiesel production chain and their potential markets. Three main possibilities of using cake from bio tropic crops – sunflower, soybean and rape – have been identified. Cake can be used as fertilizer, cattle feed and as biomass. Therefore, the by-products obtained during the extraction process can be used for various purposes, however, as practice has shown, in many cases the cake is not used for further processing. Although glycerin is known to be formed during refining, a by-product of chemical reactions that can be used in the pharmaceutical and cosmetic industries.

To study the value chain of biodiesel in Ukraine and substantiate the system of marketing the interaction of agricultural enterprises for biodiesel production, we developed a model to simulate the flow of raw sunflower and rapeseed, as the use of both crops was identified as the most common for biodiesel production in Ukraine. The processes of obtaining oil and biodiesel from sunflower and rapeseed are very similar, there are differences only in some input variables that were taken into account in the mentioned model (Lohosha and Semchuk 2020, 45-54).

Figure 3. The general structure of the model



Source: developed by the author

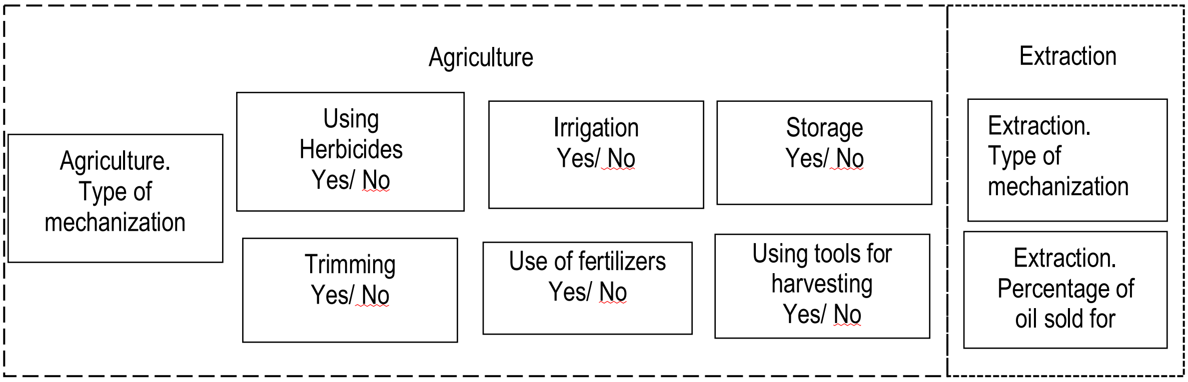
The purpose of the simulation was to determine the biodiesel production chain, which presents different scenarios, and the input variables can be easily changed. In addition, the purpose of the simulation was to calculate and add up the total cost and the cost of each activity of the biodiesel production chain for different scenarios.

This model is a structured description of the biodiesel production chain for one hectare of land over a ten-year period. It consists of three main modules: agriculture, extraction and refining. These modules contain five different streams: mass flow, expenses flow, diesel flow, electricity flow, and associated energy flow. There are two end users in the biodiesel production chain: the oil consumer and the biodiesel consumer. Potential use of the by-product (cake) is also included in the model. To summarize the data from the model, individual modules are connected to the summation module, which analyzes all the data (Fig. 3) using the total flows of each module. Due to the final flows, each model can be analyzed separately.

All streams pass through three modules. In each of them, each thread has a different effect, which contributes to the overall final value of the function. Each activity is defined by different actions and different input variables. An example of a particular activity is «land rental and cultivation costs». Input variables are fixed values, such as «cost of equipment», and individual actions are determined from input variables and other actions, such as «labor training time». The model contains equations for individual activities and input variables. Many equations for certain activities contain conditional statements, such as «if», «else», etc., because some types of equipment, tools and methods are incompatible (Pryshliak, *et al.* 2020, 1634-1648).

To ensure the management of input variables and simulation scenarios, the development of a special interface is envisaged (Fig. 4).

Figure 4. Input variables and scripts management interface



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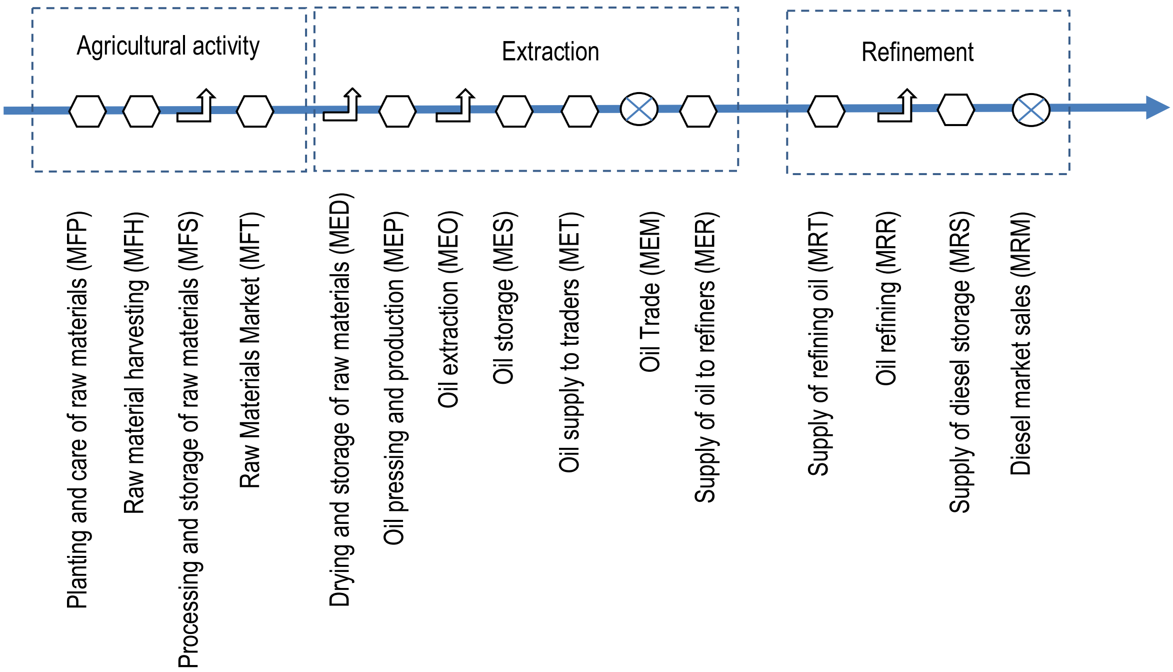
Flows in the model.

Mass flow is the main flow in the production chain, consisting of raw materials for biodiesel (in kg). The mass flow of raw materials originates from the module of agriculture in the form of sunflower and rapeseed harvest, and then - in the value chain is converted into oil and biodiesel (Fig. 5).

Figure 5. Mass flow of the model with three modules and its 15 activities

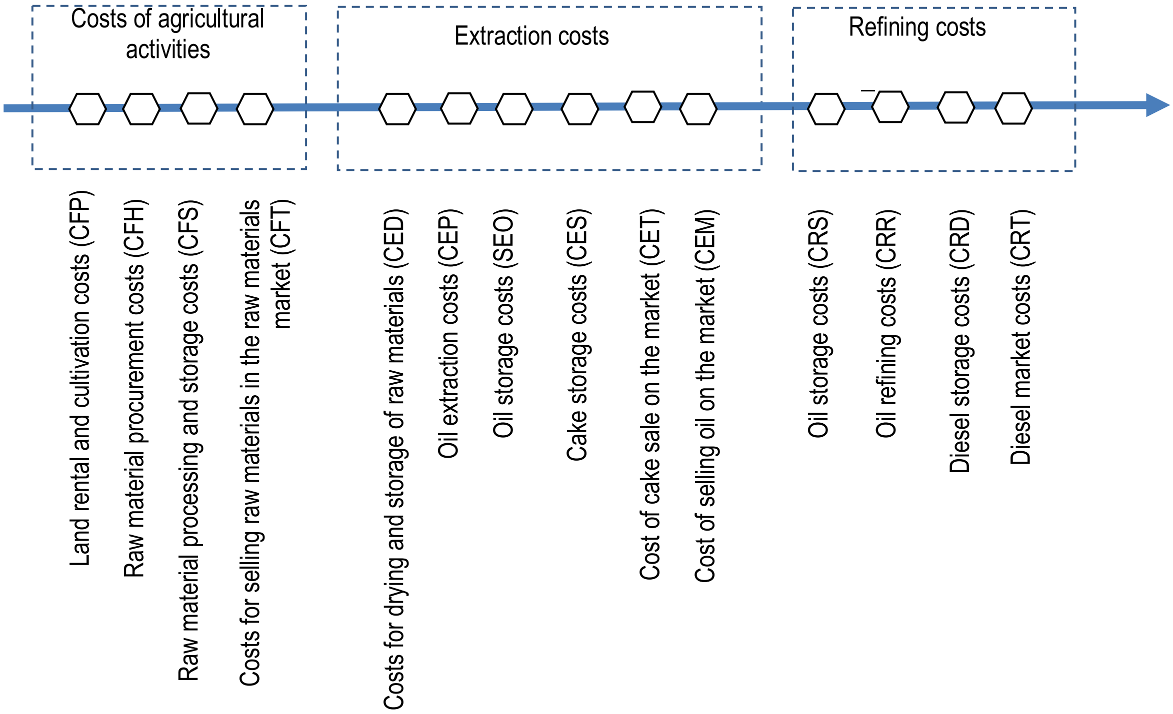


Source: developed by the author

Due to the mass flow, various by-products: moisture, cake and glycerin - pass from the main mass stream to new streams, where the cake is the only by-product for which the model provides for further use. Activity with the mass flow section is indicated by an arrow sign in Fig. 6. The final markets of the production chain are marked with a crossed circle.

Expenses flow. As shown in Fig. 6, the cost stream consists of 14 activities, as a result of which the total cost of creating a product is added to the individual costs in USA dollars.

Figure 6. Expenses flow model with three modules and 14 activities



Source: developed by the author

The total cost (C) of the biodiesel production chain is calculated by adding the cost of each module. To calculate the total cost of the biodiesel value chain, the total cost of agricultural activity (CF), the total cost of extraction (CE) and the total refining cost (CP) are added, as shown in 3.1.

$$C = CF + CE + CR \quad 3.1$$

The cost of each module is calculated by adding the cost of each activity in the module, and the cost of each activity is based on the individual actions and input values of the values associated with the activity.

The total costs of CF agricultural enterprises are calculated by 3.2 consisting of the cost of renting and cultivating CFP land, the cost of harvesting CFH raw materials, the costs of processing and storing CFS raw materials, and the costs of selling raw materials in the CFT raw materials market. This principle is used both to calculate the CE for (3) and to calculate the CP for (4).

$$CF = CFP + CFH + CFS + CFT \quad 3.2$$

$$CE = CED + CEP + CEO + CES + CET + CEM \quad 3.3$$

$$CR = CRS + CRR + CRD + CRT \quad 3.4$$

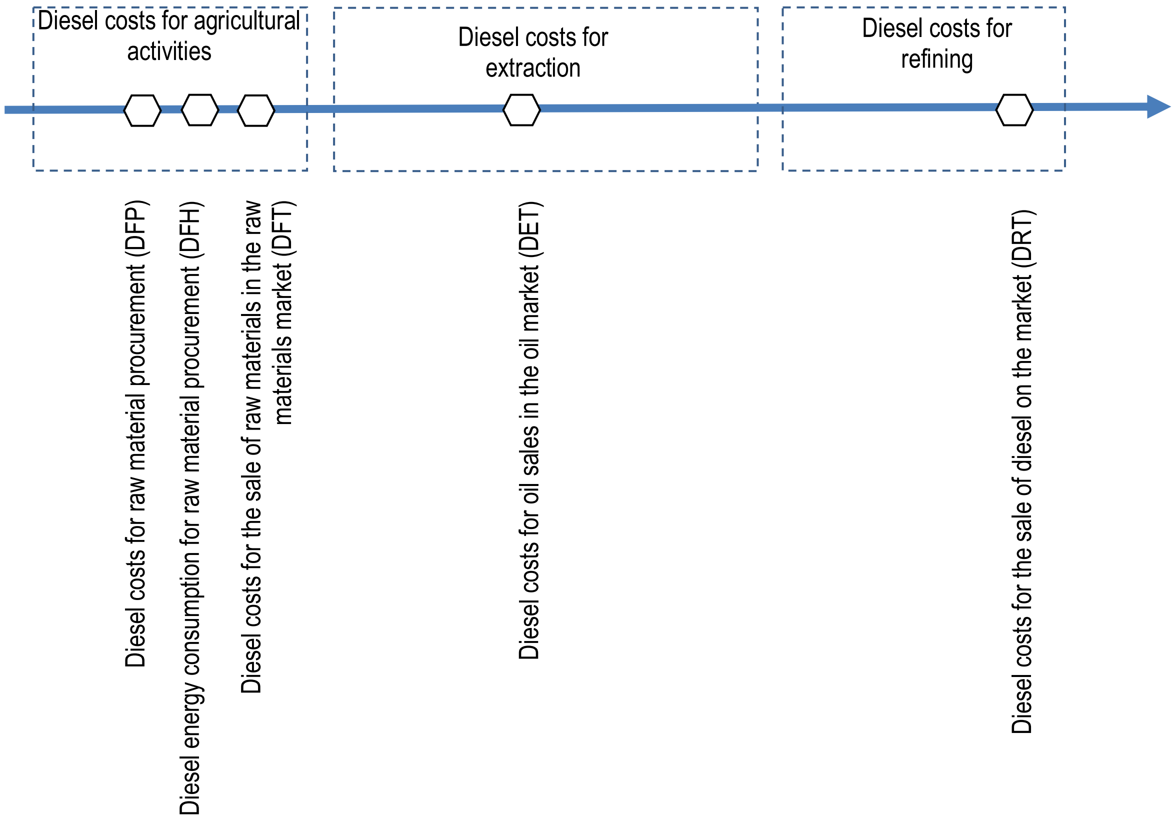
The same calculation concept is used for diesel flow calculations, electricity flow calculations and bound energy flow calculations, as the module structure, activities, ancillary actions and inputs are similar.

Diesel flow. As can be seen in Fig. 7, the diesel flow is formed by five activities, which involve the use of diesel in liters throughout the chain. This diesel is a diesel fuel that is used in various technological processes in the production of biodiesel, in particular in tractors for plowing and transportation. As in the flow of costs, total diesel consumption is calculated by adding the use of diesel fuel during the implementation of each activity in the value chain.

The total diesel consumption for the value chain of biodiesel D is calculated by 3.5.

$$D = DF + DE + DR \quad 3.5$$

Figure 7. Diesel flow model with three modules and five activities



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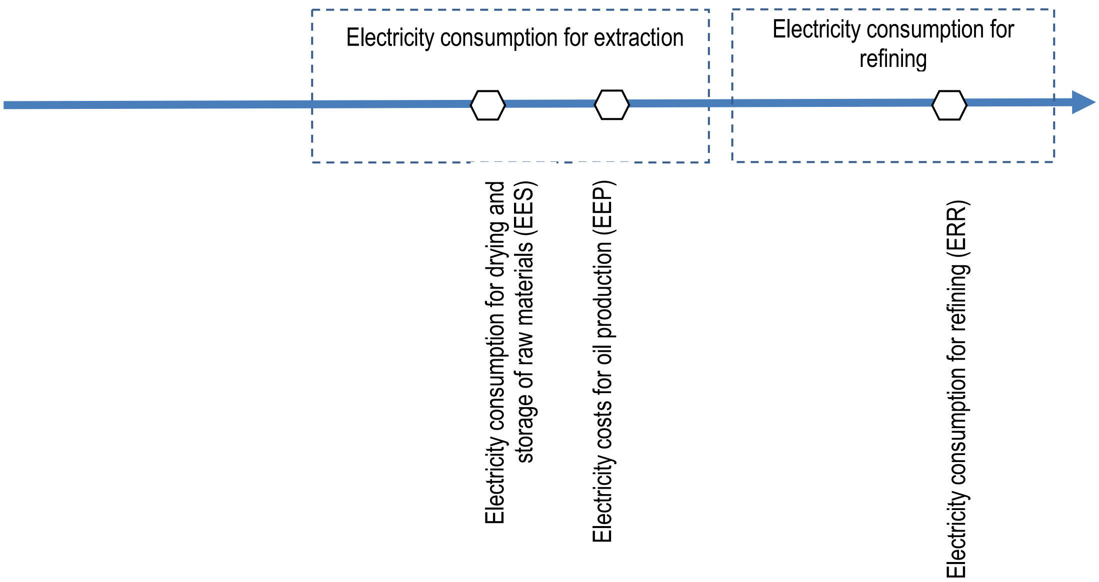
The total use of diesel fuel in agricultural activities DF, in the extraction of DE and in the refining of DR is calculated by 3.6, 3.7 and 3.8.

$$DF = DFP + DFH + DFT \tag{3.6}$$

$$DE = DET \tag{3.7}$$

$$DR = DRT \tag{3.8}$$

Figure 8. Electricity flow model with two modules and three activities involving its use



Source: developed by the author.

Electricity flow. As shown in Fig. 8, the flow of electricity involves the implementation of three activities during which electricity is used (in kWh). In the extraction module, electricity is generated in diesel generators, and in the refining module, it is taken from the state electricity grid. In the summation module, electricity is converted into base energy, which must be used to generate electricity. Converting all types of energy to base energy allows you to add electricity to diesel and combined energy.

The total electricity consumption in the cost chain of biodiesel (E) is calculated by 3.9.

$$E = EE + RR \quad (3.9)$$

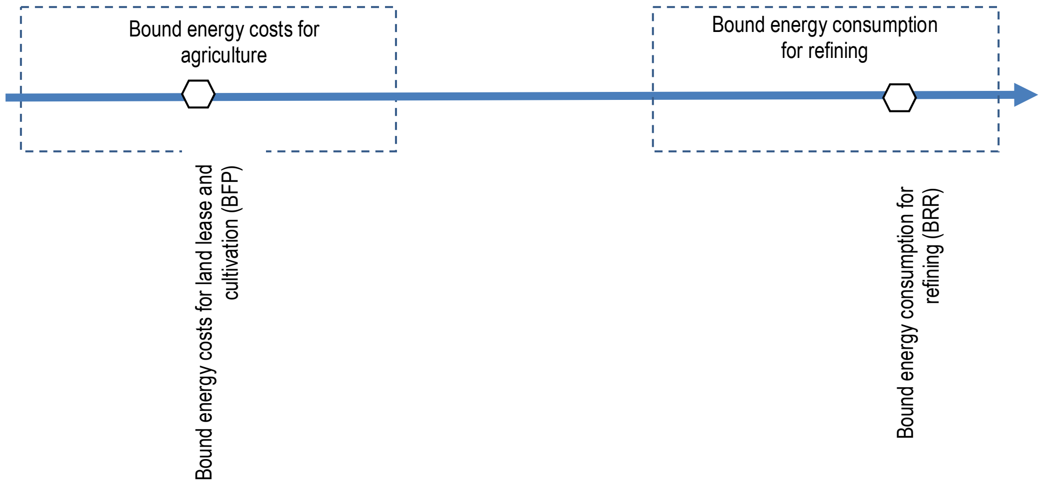
The total electricity consumption during oil extraction (EE) and the total electricity consumption during refining (ER) are calculated by (10-11).

$$EE = EES + EEP \quad (3.10)$$

$$ER = ERR \quad (3.11)$$

The flow of bound energy. As shown in Fig. 9, the flow of bound energy involves two activities in which energy is expended using different chemicals: fertilizers, pesticides and substances for the refining process. You can add the values of two activities to calculate the total use of connected energy for the entire biodiesel value chain.

Figure 9. Bound energy flow model with two modules and two corresponding activities



Source: developed by the author

The total associated energy consumption for the biodiesel value chain (B) is calculated by 3.12.

$$B = BF + BR \quad (3.12)$$

The total associated energy costs for agricultural activities (BF) and the total associated energy costs for refining (BR) are given in 3.13 and 3.14 below.

$$BF = BFP \quad (3.13)$$

$$BR = BRR \quad (3.14)$$

Module structure. In fig. 10 shows the part of the module of agriculture related to the cultivation and care of biodiesel crops. The other modules of the model are built on the same principles. The model has a scalable design that allows you to easily change the values of input variables in order to simulate a new specific scenario or update the results with new data.

In fig. 10 the mass flow is shown at the top. The mass flow shown in the figure is also the beginning of the overall flow and reflects the characteristics of agricultural activity. It is regulated by the activity «Planting and care of raw materials», which depends on the productivity of one hectare of land in the model. In fig. 10 and throughout the model, this relationship is illustrated by the arrows that go from «Productivity» to «Planting and care of raw materials».

Land productivity is based on base yields and increased yields of inputs caused by agricultural activities such as fertilizers. Input to account for fertilizer can be included or excluded in the model in order to assess their impact on the entire value chain.

Some additional variables also affect the model and can be taken into account or excluded, such as labor, costs, and energy consumption. Examples of these variables are presented in Fig. 10: «Herbicides», «Fertilizers», «Type of mechanization», «Irrigation».

To the right in fig. 10 shows two different parts of the model for calculating the time of use of labor, one – for growing sunflower «Time to grow (sunflower)» and the other – for growing rapeseed «Time to grow (rape)». The time of labor use required to grow one hectare of plant depends on various factors, such as the level of mechanization and the use of chemicals. For example, if a tractor is used instead of manual cultivation, the time is reduced. These factors are also different for different plants, as planting and maintenance methods may differ.

Characteristics of activities that lead to costs «Costs of rent and land cultivation» can be seen in the lower part of Fig. 10. The flow of costs depends on all cost factors in the above part of the model. This means that if something changes, for example, if more labor is needed, or if wages increase, the total cost will increase. The total cost also depends on what activities are performed. This model makes it possible to test different scenarios and evaluate design options for the value chain of biodiesel.

The activity of the diesel fuel flow «Diesel energy costs for land preparation and maintenance» is described similarly to the flow of costs. Bound energy flow activities «Bound energy costs for land lease and cultivation» are described in the same way as all other activities.

The flow rate, diesel flow, and associated energy flow form flows that add up to the total cost, total diesel consumption, and total associated energy consumption when the model is used. The values obtained during the simulation should be stored in order to be able to analyze the total cost of all time. When summing up the values of different flows, you can see which parts are the most expensive and energy-intensive. To facilitate data collection and analysis, partial flows are also added to the final flow, which summarizes the entire agricultural module. Next, the total and energy costs are added to the previously described summation module, which summarizes the data of the entire model.

Scenario definition. To study the value chain of biodiesel, it is necessary to perform calculations of different types of costs, volumes of energy use. To calculate these values and to study the effect of different input variables, it is proposed to use different scenarios for testing and analysis under different model configurations. Scenarios are set for individual modules so that both the overall cost chain of biodiesel and each module can be analyzed separately.

Identification of agricultural scenarios. The scenarios for the agricultural module are divided into two partial scenarios and two large-scale scenarios. The analysis should also be performed separately for sunflower and rapeseed. Agricultural scenarios and input values for each scenario may be different. The reason for including pruning in all scenarios is that it affects yields and can be easily done. Irrigation is used only in large-scale scenarios, as irrigation equipment is not widely used by small farms, but is used almost everywhere in large agricultural enterprises.

A simple partial scenario is widely represented today in agricultural practice.

The advanced partial scenario is based on a potential hypothetical scenario where farmers have access to more resources than in the simple partial scenario. In the advanced partial scenario, farmers use fertilizers, pesticides and harvesting tools. It is also assumed that this scenario uses collection points, which make transportation more efficient because fewer primitive means of transport and more tractors and trucks are used.

Large-scale agricultural scenarios involve the use of fertilizers, tools and modern tractors. It is also assumed that the extraction plant is located directly on the farm. The difference between the two large-scale scenarios is the salaries of employees. The reason for making this difference in the model is to test the wage increase hypothesis in Ukraine to investigate whether sunflower and rapeseed cultivation will remain stable in the long run with wage growth.

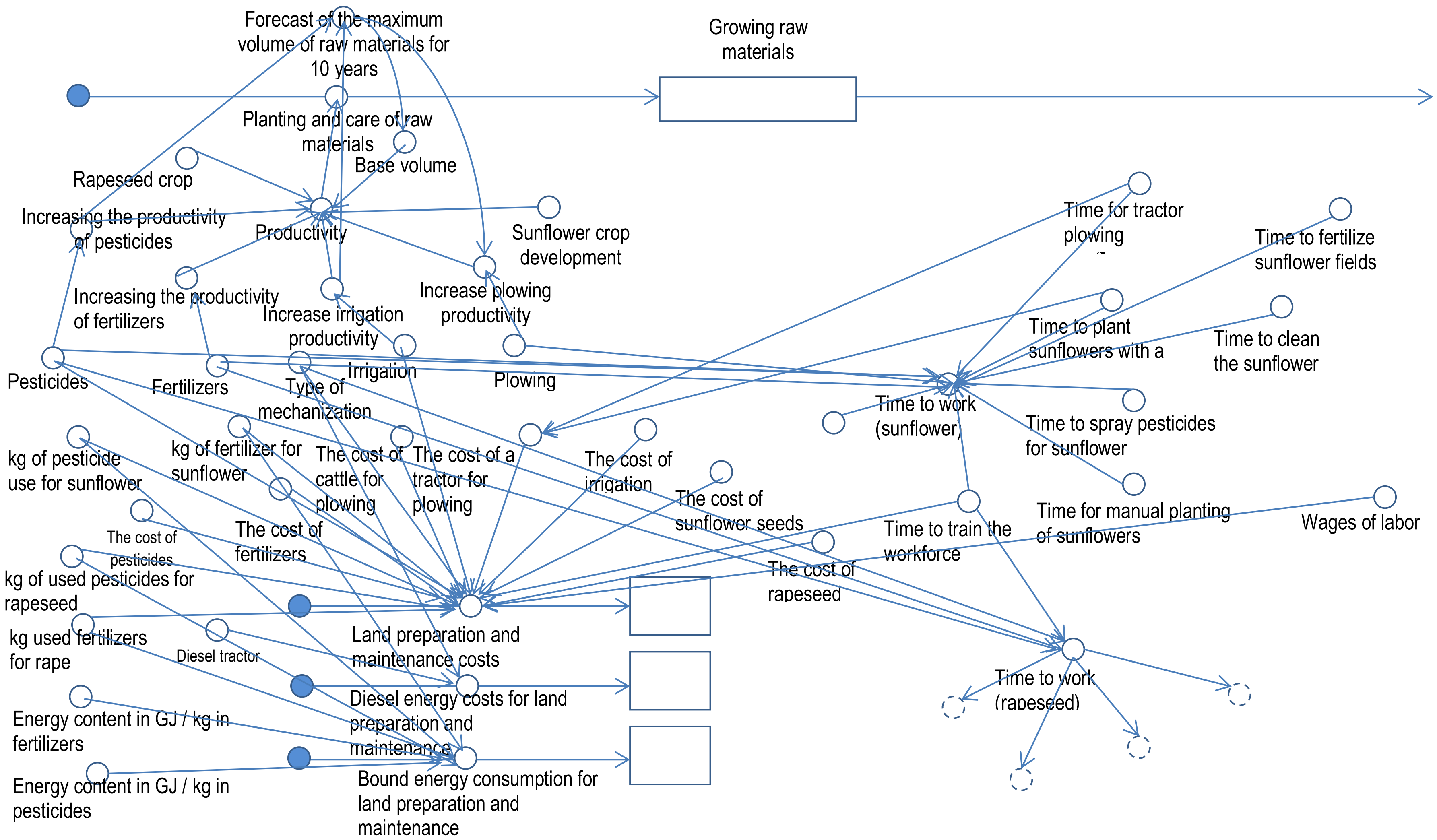


Figure 10. Part of the module of agriculture with mass flow, expenses flow, diesel flow and associated energy flow, different activities and variable input data

Source: developed by the authors

Extraction scenarios. In the table. 1 describes the scenarios of the extraction module. To analyze the costs, energy use in the extraction process in the value chain of biodiesel, three scenarios are proposed, which will be analyzed separately for sunflower and rapeseed.

Table 1. Extraction scenarios

Scenario	Type of extraction	Oil yield	Sales market	Transportation to the sales market
Simple partial	Manual	30-35 %	Local	0 км
Advanced partial	Advanced equipment	40-45 %	Local	0 км
Advanced partial	Advanced equipment	40-45 %	National	up to 300 km of freight traffic

Source: compiled by the authors

In a simple partial scenario, a manual extraction machine is used. The oil produced in this scenario can be sold directly to the local market for use in diesel generators or in modified diesel engines. By selling the oil directly on the local market, the cost of extraction and transportation to the extraction site is zero.

The advanced partial scenario is based on the same assumptions as the simple partial one, except that a more advanced extraction technique is used here. As in the simple partial scenario, the oil is sold in the local market under the advanced partial scenario.

The large-scale scenario involves the use of the same extraction technique as in the progressive partial scenario, but instead of selling the oil locally, it is sold on the national market to refineries that can process it into biodiesel.

Refining scenarios. In the table 2 describes two different refining scenarios, the difference between which is at the point of sale of the diesel. The regional scenario is based on the assumption that diesel is sold in the local market. The international scenario is based on the assumption that diesel is exported to the EU market by road.

Table 2. Refining scenarios

Scenario	Outlet	Transportation to the market
Regional	Local market	300 km
International	EU	1000 km

Source: compiled by the authors

Because sunflower and rapeseed oil are refined in the same way, two different refining scenarios for two different types of oil are not considered.

Sensitivity analysis. To test the model for its sensitivity, it is necessary to conduct a sensitivity analysis. Uncertainty of variables may occur for the following reasons: the existence of a lack of prior research prior to valuation; the values of the variables are defined as averages among the various potential practices in the value chain of biodiesel.

The technical value of the variable in the sensitivity analysis indicates the level of influence that the change in the value of the variable has on the results.

If the value chain of biodiesel is properly modeled, then such a model can be used to plan the activities of agricultural enterprises in order to ensure their social, environmental and financial sustainability (Lohosha, Mykhalchyshyna, Prylutskyi, Kubai 2020, 727-750). The best way to develop a biodiesel value chain to achieve rural development is to involve small farmers in ensuring that they use advanced farming technology to grow biodiesel crops, use advanced oil extraction machines and sell oil in the local market.

More agronomic research of bioenergy crops is needed to increase the level of validity of different scenarios of the model operation. There is currently a lack of research on how best to grow bioenergy plants. The cultivation methods used by farmers today are often ineffective, not only because of a lack of capital but also because of a lack of knowledge (Pronko, Kolesnyk and Samborska, 551-560).

It is also established that there is a synergy between biodiesel production and food security. It is possible that additional income from biodiesel crops, access to tools and machines, increased knowledge of agricultural machinery and the possibility of cross-growing plants will increase food production on farms (Kaletnik and Pryshliak 2019, 96-104). However, in order to draw a sound conclusion, this issue needs to be investigated more substantially, as we have not been able to take into account all aspects of food security in this study.

The proposed model includes several activities, partial activities and variable data of the value chain of biodiesel. The model is built with the prospect of future changes, because it is the first version, there is a possibility of its further development by increasing the number of activities, partial activities and input data, such as the production of by-products. Increasing the number of activities, partial activities and variables in the model will make it possible to analyze more aspects of the biodiesel value chain.

Discussion

When compiling the model and on the basis of previous studies described in this article, it was found that to improve the use of the value chain of biodiesel and ensure social, environmental and financial sustainability, the following changes are needed:

- the Government of Ukraine needs to reduce the regulatory burden in order to facilitate access to resources for small farmers, and for larger enterprises to simplify trade with small farmers at collection points;
- to ensure the competitiveness of small businesses as actors in the value chain, collection points should be established, which will reduce trade costs, facilitate market access, make resources and tools available;
- organize a system of microloans for small farmers;
- to provide a system of training of farmers on the use of advanced agricultural technologies, processing of bioenergy crops into biofuels, communications, technology transfer within the value chain;
- introduction of effective information exchange systems between farmers;
- to achieve the maximum financial return of the grown raw materials it is necessary to invest in efficient extraction machines with high yields of finished products;
- maximize oil sales in local markets in order to realize environmental, economic and social benefits in the value chain of biodiesel;
- to ensure the mass use of cake as fertilizer or biomass to improve the energy ratio and minimize the environmental impact of entities and activities in the value chain of biodiesel;
- intensify agronomic research of bioenergy crops in order to maximize their productivity and minimize the risks of biofuel production;
- improve and formalize communication in the value chain so that information from research institutions reaches agricultural enterprises, farmers, government agencies and public organizations.

Conclusion

When forming the marketing model and the corresponding marketing policy of the enterprise, it is methodologically important to form effective value chains as a basis for competition in the market. The theoretical approach to the formation of the value chain within the marketing model of an individual agricultural enterprise is substantiated. At the same time, value chains are seen as production networks in which businesses use competitive resources and operate in an institutional environment, a network of horizontally and vertically connected enterprises united by a partnership model of interaction.

To study the value chain of biodiesel in Ukraine, an appropriate model was developed to simulate the flow of raw sunflower and rapeseed, as the use of both crops was identified as the most common for biodiesel production in Ukraine. The model differs from the existing ones in that it takes into account different scenarios to determine the total cost of biodiesel production, as well as the cost of individual activities in the value chain. The model also includes agriculture, extraction of oil for processing into biodiesel and its refining. In addition, the model takes into account different resource flows: mass flow, expenses flow, diesel flow, electricity flow, and associated energy flow. For each flow and for each activity, the model determines the costs. The model can be changed according to the needs of the real enterprise by adding or deleting different blocks.

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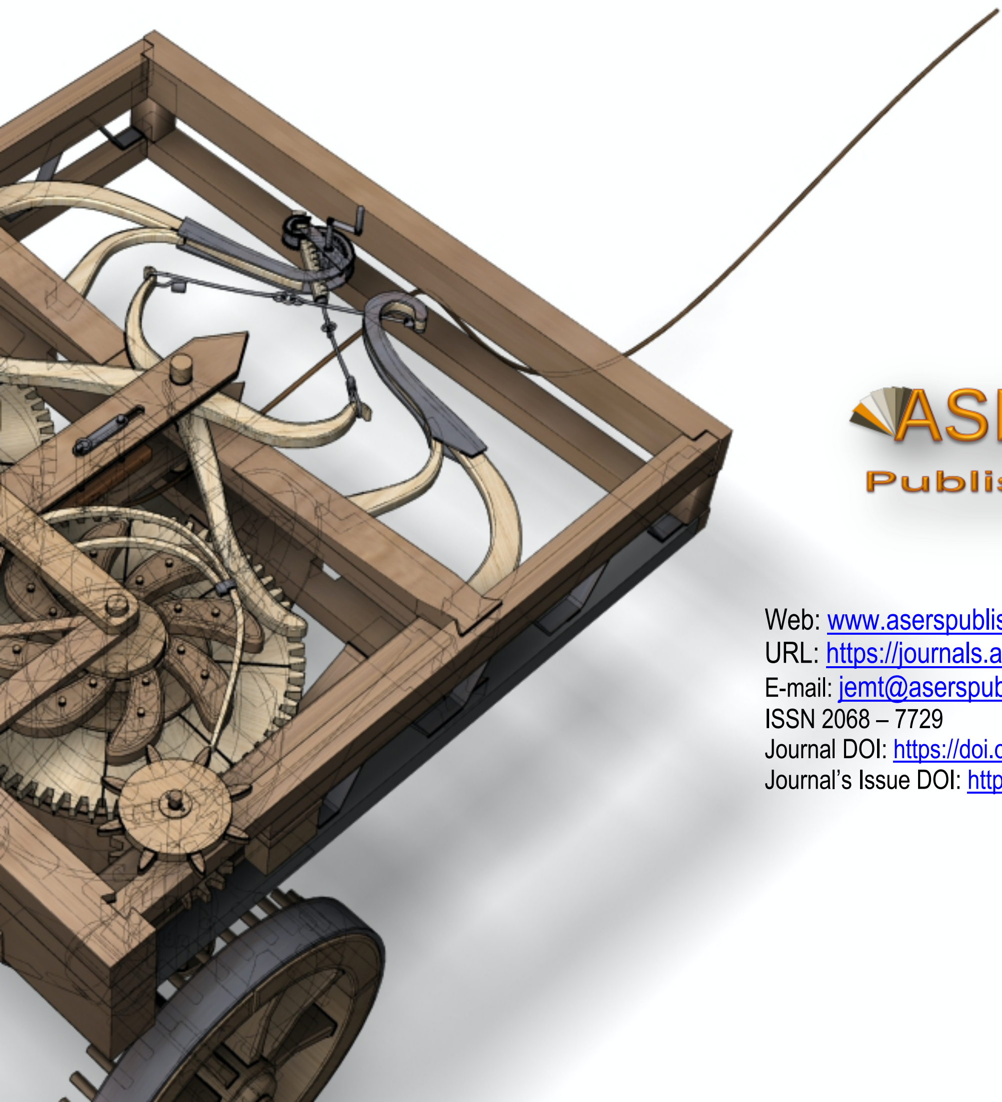

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