1. ІННОВАЦІЙНІ ПРОЦЕСИ В ЕКОНОМІЦІ

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RESTRUCTURING OF SOCIO-ECONOMIC SYSTEMS AS A COMPONENT OF THE FORMATION OF THE DIGITAL ECONOMY IN UKRAINE [1]

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The article examines the main problems of restructuring socio-economic systems as a component of the formation of the digital economy. The concept of "system", its elements, the relationship between them, as well as the functional environment of the system are considered. The main characteristics of the parameters of the state of the system are analyzed. It is noted that systems are combined into larger system formations, called supersystems. The concept of system structure is defined, its main parameters are given. Categories such as hierarchy and function play an essential role in the study of the functioning of systems. The authors determined that in order to fulfill the tasks of its existence, any system must perform a set of interrelated functions. The more efficiently each of these functions is performed, the more efficiently the whole system works, and the higher the possibility for the system to accumulate free energy, and any system reproduction process should be viewed as a whole, greater than the sum of the individual sub-processes of which it consists. Time can be viewed as another horizontal axis of measurement in which the system is formed. This dimension can be figuratively called the "timeline" or "lifeline" of the system, and the time parameters (sequence, duration, pace, speed, level of synchrony of processes, switching time) reflect the quantitative and qualitative aspects of individual processes (subprocesses) of system reproduction. The transition of society to a new formation is associated with changes in the state of socio-economic systems, an integral part of which are processes of restructuring (changes in the parameters that form their structure). The authors proposed a conditional scheme of system formation as a spatial object and process and characterized certain types of restructuring of socio-economic systems in modern digital transformations. As an illustration of such processes the structural changes in the energy sector of Ukraine for the period 2010–2020 are analyzed. This proves that the structure of economic systems is the most important subject of management of socio-economic development, and the analysis of restructuring processes is an effective tool to justify management decisions and regulation of economic processes to ensure sustainable socio-economic development.

***Keywords**: economy, information, process, restructuring, system, transformation, digitalization.*

JEL Classification*: *D83, L86, O33

Introduction. The development of any system involves changes in the parameters of its state. One of the main characteristics of systems is their structure. A change in the structure is the basis of the content of the transformation processes that accompany the phenomenon of development. Indicators of system restructuring, i.e., changes in the main parameters of its structure, are the key characteristics of its development, in particular, determining the direction and pace of this process.

Socio-economic systems are no exception to this rule, which means that everything said about the structure and restructuring of systems can be applied directly to them. The beginning of the XXI century is associated with a significant acceleration of socio-economic development. Therefore, it is no coincidence that more and more attention of researchers is drawn to the transformation processes in society, among which *restructuring* is a leading one.

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1. The concept of system and structure

The concept of development is inextricably linked to the concept of a system. If something can develop, it must be a system. Everything in the world, from the smallest particles to megacosmic formations, is a system, which in turn consists of systems.

System (from the Greek "system" – a whole composed of elements) is one of the oldest scientific concepts, used long before Aristotle and Plato. The ancient definition is probably the most concise and accurately reflects the essence of this category: *"A system is more than the sum of its parts; it is an indivisible whole."*

Nowadays, there are many approaches to explaining the system (Acaroglu, 2017; Backlund, 2020; Bailey, 2006; Gall, 1986). They allow us to formulate its definition.

System – any set of elements (subsystems), combined into a single whole process of interaction (material and information exchange) to implement a standard function (achieving a common goal).

An element of a system can be considered its structural component, which cannot be decomposed further without changing its properties. (What, 2021).

The relationships between the elements are functional dependencies between the components of the system in relation to the functions they perform and the processes of metabolism. Relationships are formed on the basis of various principles: complementarity, mutual subordination, equal interaction, mutual benefit and others.

The functional environment of the system – a set of laws, algorithms, and parameters characteristic of the system, according to which the interaction (exchange) between the elements of the system and the functioning (development) of the system as a whole (Ngyen, 2022).

The main characteristic of any system is its state. The state of a system is a set of values of quantities inherent in a given system: the parameters of the internal elements of the system, the connections between them, as well as the connections between the system and the environment; these characteristics are called *state parameters*.

The state of *the economic system* is determined by the volume of commodity and cash flows passing through the system, the balance of its income-expenditure, etc. The situation indicators are sales volume, cost of goods, selling price, profit, etc.

The system development process is inextricably linked with the change of its state. As a result, the parameters that determine the state of the system change.

The functional activity of systems is realized in the process of interaction between the elements of the system. It is the result of not just mechanical contact of subsystems with each other, but is reproduced through complex processes of mutual exchange of substance, energy and information.

The nature of the relationship between the elements of the system plays a critical role. And they depend on the specificity of the links between the elements in the structural construction of the system and the levels of their co-subordination in the hierarchy of the system. That is why the study of the prerequisites for the effective functioning of the system and the phenomenon of synergy requires a systemic understanding of the categories of "structure" and "hierarchy".

The very notion of a system (recall its short definition: a whole greater than the sum of its constituent elements) implies that it is formed of separate elements (components, objects, entities). These components are also systems, only at a lower (subordinate) level. They are called subsystems. The components that make up subsystems can be called subsystems.

In turn, systems are combined into larger system formations, called supersystems. Systems formed at a level even higher than supersystems are called supersystems. An example is the following system series: subsystems – particles; subsystems – atoms; systems – molecules; super-systems – cells; super-supersystems – organisms.

The interrelation of elements in the system is characterized by structure, and the multi-level (resembling a matryoshka doll) design of the system is a hierarchy of its subsystems.

The structure is a category that characterizes the mutual order and system of relations (connections) of elements within a single whole (Structure, 2022; Mathiassen, 2022; Urry et al., 2017).

The structure, which describes the relationships and connections between the components of the system, characterizes a certain degree of detail and accuracy of the information content of the system. The structure of the system can also provide insight into its external relationships. However, it is possible to say otherwise: the structure of a supersystem characterizes the information picture of the interaction of its constituent systems. After all, the supersystem is the external environment of each system.

If one considers the system in space, its structure can be characterized by the following main parameters:

– *the number of elements* in the system;

– *the number of connections* that characterize the complexity of the system;

– *intensity* (frequency) of the interaction of elements, i.e., the number of connections per element;

– *the nature of internal relations* (characterizes the internal structure of the system);

– *the number and character of external relations* (depicts the system's interaction with the environment).

As follows from the above material, the elements (subsystems) in the system do not exist by themselves but are interconnected. Connections are any relationships between parts of a system.

Relationships characterize the interdependence and mutual constraints between the elements of the system. The exchange of matter, energy, and information between elements depends on them. Connections play a vital role in the system, determining its information content (Mathiasen, 2022; Urry et al., 2017).

Categories such as *hierarchy and function* play a vital role in studying the functioning of systems.

Hierarchy is a functional subordination of the elements of the whole (its subsystems) from lower to higher. Each level of this hierarchy is called the rank of the system. Accordingly, it is possible to talk about the rank of atoms, the rank of molecules, the rank of cells, organisms and others. Each hierarchical level (rank) of the system performs its functions.

The function is a set of processes that are regularly performed by the system and ensure the general existence of the system. The higher-level system acquires *new properties* and begins to perform functions, the performance of which can provide its constituent elements (subsystems) with their activities.

The functions of a productive enterprise are determined by the activities that the market dictates to that enterprise. When the products previously produced by an enterprise are not in demand in the market, the enterprise is forced to develop new products (if, of course, it has the necessary resources: sufficient capital, necessary production facilities, skills, etc.). A change in demand is not the only reason that can force a company to change its function in the market system. It can also be caused by changes in raw material markets (e.g., price increases due to shortages), the behavior of competitors, changes in natural conditions, communication problems (in particular, blocking transportation channels), etc.

To perform the tasks of its existence, any system must perform a set of interrelated functions, the main of which are:

– collection, storage, and analysis of information;

– maintaining the spatial relationship (i.e. structure) of individual components (subsystems) of the system;

– maintaining in time the order of processes occurring in the system, including the synchronization of the activities of individual units;

– implementation of processes of transformation of material-energy-information flows (from now on – flows) to obtain free energy;

– transportation of these flows inside and inside the system;

– reproduction (restoration, reproduction) of functional subsystems that lose (deteriorate) their properties as a result of “wear” or under the influence of those harmful agents that enter the system with metabolic flows (these are analogs of capital and current repairs of system components);

– removal of substances, energy, and information from the environment (negative entropy);

– reduction of system waste (positive entropy) into the external environment;

– protection of the system from the negative impact on the environment;

– adjustment (adaptation) of the activities of individual subsystems depending on the parameters of the flows entering the system and circulating in it; such transformation, in particular, is necessary for the deviation of parameters of flows from optimum values and also a change of properties of the system (for example, its temporary adjustment).

The more efficiently each of these functions is performed, the more efficiently the whole system works, and the more likely the system is to accumulate free energy. The efficiency of a particular function can be determined by the ratio of the amount of useful energy directly spent on that function to the total energy consumption. This is one type of system efficiency. The efficiency of the whole system and its subsystems will be the higher, the less is the loss (dissipation) of energy. In a broad sense, the generalized concept of "energy" includes all costs of the system of material, energy and information resources.

Any open stationary system is not only a spatial object (consisting of individual spatial components) but also a process that continues continuously in time. In particular, it is formed of individual subprocesses that run in parallel and sequentially. In other words, the process of functioning of the system can also be considered a system consisting of parts of the general cycle of reproduction of the system or phases. This means that the basic definition of the system (more than the sum of its parts; it is an indivisible whole) must fully take into account not only the spatial but also temporal aspects of the reproduction of the system.

When it is said that a system is formed in the process of interaction between its various elements (parts), it is often implied that these elements represent different parts of space, which perform coordinated actions in a single temporal continuum. This means, in particular, that at each moment of time of a certain period the elements simultaneously carry out joint activity (each – their own).

However, this is only part of the truth, which is more complex and complete than what has been said. After all, it can be a system of different states of the same system or its element, fixed at other moments of time.

Thus, any process of reproducing the system's state should be considered as *more than the sum of its parts; it is an indivisible whole*. This, in turn, means that any of the subprocesses, torn from the rhythm of the general process of system reproduction, completely or partially loses its functional orientation and, therefore, the content of its realization. The same applies to the results obtained in the course of such a subprocess.

Time can be conventionally considered as another horizontal axis of dimensions in which the system is formed (if to consider three spatial dimensions as conditional integral vertical axis characterizing its current state) (Figure 1). This dimension can be figuratively called "timeline" or "lifeline" of the system. Each system has its past, present and future. In their unity and integrity, they form a systemic whole – a system of transformational transformations of a particular system.

Time parameters are economic indicators that are directly or indirectly formed, taking into account time indicators. Time parameters reflect the quantitative and qualitative aspects of implementing individual processes (subprocesses) of system reproduction. Among the main ones are:

– sequence;

– duration;

– temp;
– speed;
– the level of synchronicity of processes;
– switching time.

All of these factors are equally important for some reproductive processes. For others, only some of them are.

All the above parameters of space and time of the system and the functions performed by the system and its constituent elements are the basis for the formation of what is called structure and which determines *the mutual order and relationships of elements in the system*.

2. Restructuring of socio-economic systems in the course of digital transformations

The transition of society to a new formation is associated with changes in the state of socio-economic systems, an integral part of which is restructuring. Restructuring of systems is a phenomenon of changing the parameters that form their structure. Schematically some types of restructuring of socio-economic systems in modern digital transformation are presented in Table 1.

It should be noted that the characteristics of restructuring shown in Table 1 can demonstrate, relatively speaking, the "telescope effect". In other words, with a more detailed analysis, each of them can be divided into separate components of restructuring.

In particular, when the structure of the macroeconomic system is transformed by such an indicator as "the nature of internal relations", there may be substructural changes that depend on changes in several parameters:

– change in labour productivity in various parts (areas) of the economic system;
– change in profitability (share of capital) for the year;
– change in bank interest rates (which may affect the development of different sectors in different ways);
– change in the rent for the use of different types of natural resources;
– change in the tax system;
– transforming the efficiency of various natural resources;
– change in prices;
– different rates of scientific and technological progress in other fields, etc.

Other indicators characterize the restructuring of individual sectors of the national economy. In particular, Table 2 shows indicators illustrating the impact of renewable energy sources on the structure of the energy sector of Ukraine.

Speaking of the structural changes associated with the digital transformation of the global economy over the past 20 years, there are several specific indicators that influence

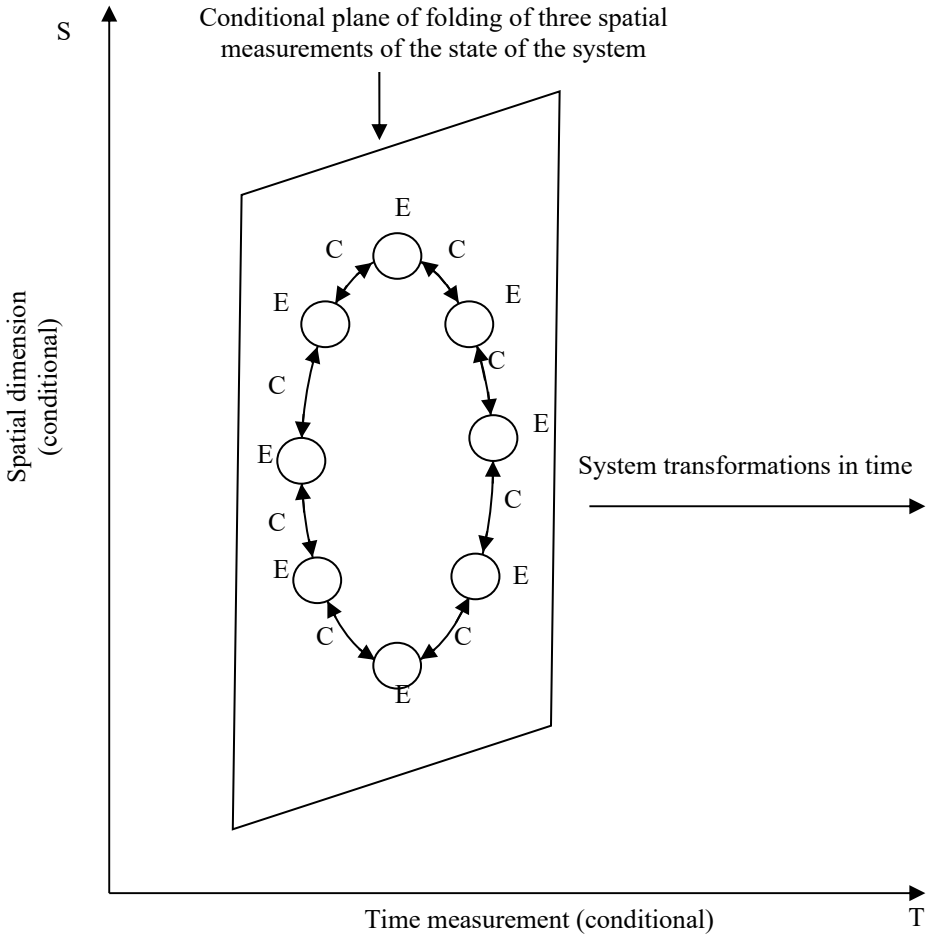

Figure 1 – Conditional scheme of system formation as a spatial object and process (E – element of the system, C – connections between elements)

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Table 1 – Components of restructuring of economic systems

Types of changing characteristics	Changing characteristics	An example of modern restructuring of economic systems
Spatial characteristics	Number of elements. Number of connections. The intensity of interaction of elements. The nature of internal connections. The nature of external relations	The transition from the concentration of individual enterprises in the space to the distributed horizontal networks of a large number of production units, in particular, the creation of EnerNet
Time settings	Sequence. Duration. Tempo. Speed. The level of synchronicity of processes. Switching time.	Transition from time-concentrated sequential production cycles to time-concentrated virtual enterprises with synchronous activities
Functions	Collection and analysis of information. Play links. Providing time parameters. Transformation of material and information flows. Transportation of materials and information. Reproduction of subsystems. Extraction of energy from the environment. Waste disposal in the environment. System protection. Adjustment of subsystems.	The transition from dominant material production to dominant information production. Transition from anthropogenic to cybergenic control of production and consumption processes. Dematerialization of processes of transportation and storage of products.

the nature of the processes of restructuring of economic systems:

– intensification of information processing at the individual level (the number of personal computers increased from 140 million in 2000 to 7,500 million in 2020);

– intensification of mobile communication between the population of the Earth (change from 100 to 7800 million mobile phones);

– networking of the world's population (change: from 80 to 4200 million Internet users);

– change in the structure of energy supply (increase in the share of "green" energy from 1% in 2000 to 25% in 2020);

– additivity of production processes (an increase of 3D printers by 2000 times);

– digitization of information (increasing the share of digital data from 50% to 99%);

– cyberization of information processes (increasing the percentage of data generated by machines from 10% to 50%).

This is only a small part of the indicators that characterize the processes of restructuring of economic systems in the course of digital transformation. These changes are occurring in all sectors and parts of socio-economic systems.

Restructuring processes are the obvious result of the digitalization of socio-economic systems. In turn, restructuring itself acts as a source of new trends in the development of social systems, setting new vectors for the efforts of people and the orientation of commodity-money flows.

These properties of the phenomenon of restructuring allow the characteristics describing this phenomenon to perform various functions of analytical tools. The main ones include:

– analysis of quantitative and qualitative parameters of processes occurring in economic systems;

– diagnostics of problems and risks of business processes;

– forecasting trends in economic systems;

– definition of directions of priority investment and reinvestment;

– creation of funds to prevent possible economic and social problems;

– determination of directions of development of necessary institutes and providing economic and social spheres in regions, the countries, corporations;

Table 2 – Structural changes in the energy sector of Ukraine for the period 2010–2020

Indicator	Year	
	2010	2020
Solar energy production (PV) in the world, GW	23	627
The multiplicity of growth, times	–	27
The share of renewable energy (including hydro), %	5	30
The multiplicity of growth, times	–	6
The specific cost of solar energy (PV), USD / kWh	0.37	0.06
Multiplicity of reduction, times	–	6

formation of motivational tools to increase the competitiveness of socio-economic systems.

As can be seen, the characteristics of the structure of economic systems are an important subject in the management of socio-economic development. Any processes in society inevitably cause the transformation of the structure of economic systems as well. The analysis of restructuring processes is an effective tool for substantiating managerial decisions and regulating economic processes to ensure sustainable socio-economic development.

Conclusions. Society's transition to a new socio-economic formation in the course of three simultaneous industrial revolutions (Industry 3.0, 4.0, 5.0) is accompanied by an intensive restructuring of economic systems. It changes the composition and qualitative characteristics of economic subjects, production and consumption processes. Indicators of restructuring are an effective tool for substantiating decisions to determine the adequate directions of human development to optimize commodity and cash flows.

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РЕСТРУКТУРИЗАЦІЯ СОЦІАЛЬНО-ЕКОНОМІЧНИХ СИСТЕМ ЯК СКЛАДОВА ФОРМУВАННЯ ЦИФРОВОЇ ЕКОНОМІКИ В УКРАЇНІ

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У статті досліджено основні проблеми реструктуризації соціально-економічних систем як складової формування цифрової економіки. Розглянуто поняття «система», її елементи, взаємозв'язки між ними, функціональне середовище системи. Проаналізовано основні характеристики параметрів стану системи. Зазначено, що системи об'єднуються у більші системні утворення, які називаються надсистемами. Визначено поняття структури системи та подано її основні параметри. У дослідженні процесів функціонування систем дуже важливу роль відіграють такі категорії, як ієрархія та функція. Авторами визначено, що для виконання завдань свого існування будь-яка система має здійснювати комплекс взаємопов'язаних функцій. Чим ефективніше виконується кожна з зазначених функцій, тим ефективніша діяльність усієї системи, і тим вища можливість накопичення системою вільної енергії, а будь-який процес відтворення стану системи слід розглядати як ціле, що більше суми окремих підпроцесів, з яких воно складається. У свою чергу, час умовно можна вважати ще однією, горизонтальною віссю вимірів, у яких формується система. Цей вимір може бути названий образно «лінією часу» або «лінією життя» системи, а параметри часу (послідовність, тривалість, темп, швидкість, рівень синхронності процесів, час

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перемикання) відображають кількісні та якісні сторони реалізації окремих процесів (підпроцесів) відтворення системи. Перехід суспільства до нової формації пов'язаний із зміною стану соціально-економічних систем, невід'ємною складовою чого є процеси реструктуризації (зміни параметрів, які формують їх структуру). Автори запропонували умовну схему формування системи як просторового об'єкта та процесу та охарактеризовано окремі види реструктуризації соціально-економічних систем в ході сучасних цифрових трансформацій. Як ілюстрація таких процесів проаналізовано структурні зрушення в енергетичному секторі України за період 2010–2020 років. Це доводить той факт, що характеристики структури економічних систем є важливим предметом управління соціально-економічним розвитком, а аналіз процесів реструктуризації є дієвим інструментом обґрунтування управлінських рішень та регулювання економічних процесів з метою забезпечення сестейнового соціально-економічного розвитку.

Ключові слова: *економіка, інформація, процес, реструктуризація, система, трансформація, цифровізація.*

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