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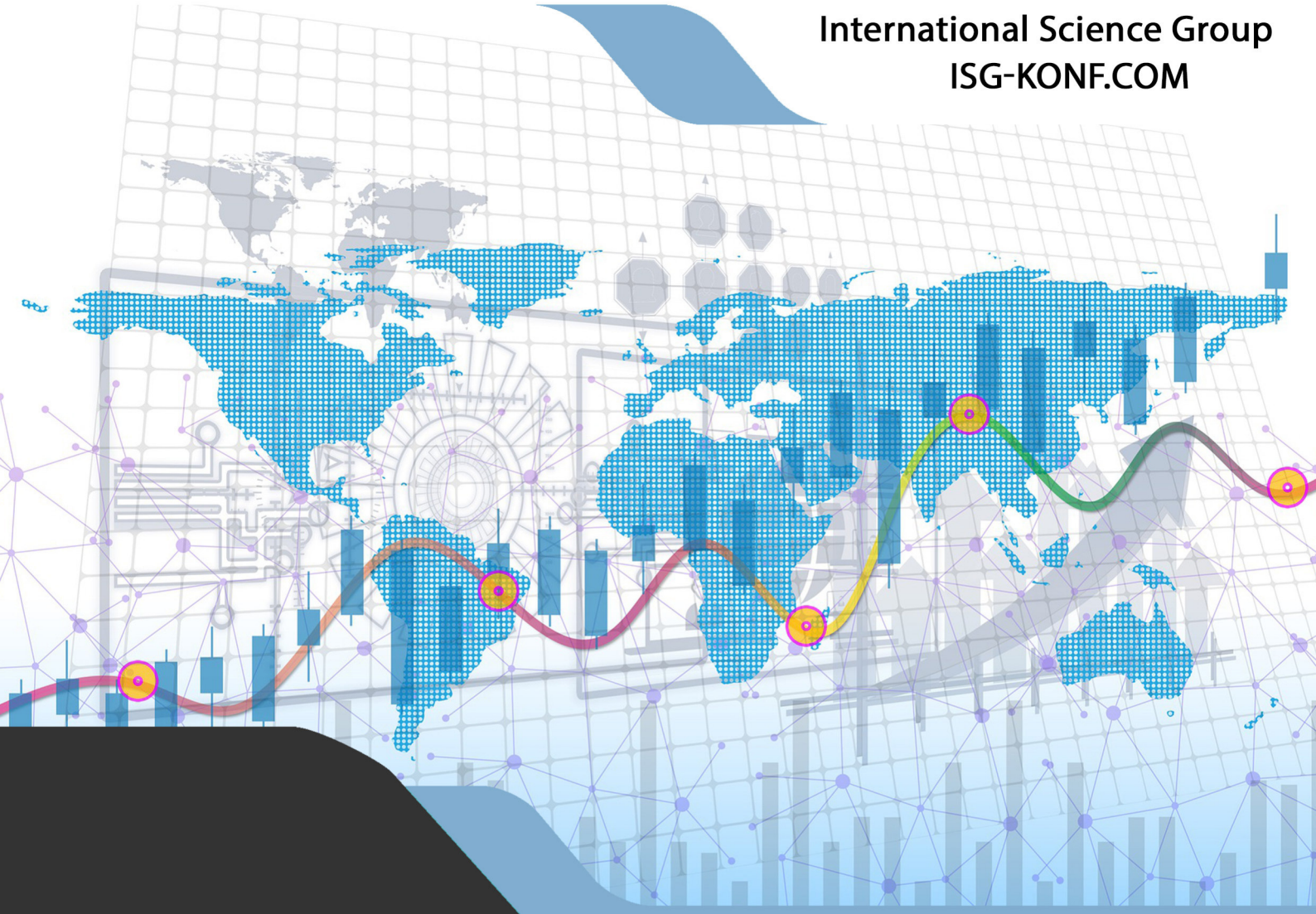

THEORETICAL FOUNDATIONS IN ECONOMICS AND MANAGEMENT

Collective monograph

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7.3 A system of criteria and indicators for assessing the dynamics of the state of socio-economic and environmental systems

The main feature of the development of socio-economic systems is the key role of the human factor in it. It is the person who sets the vector of development in such systems, determining the main goals the system should strive for in its development. On the other hand, a person acts as the leading implementer, providing by his activity the primary means for achieving the set social and/or economic goals (for example, satisfying certain material or spiritual needs, making a profit, etc.).

Any socio-economic systems are to some extent connected with nature, which serves as a source of resources, a living environment, and a factor in the self-reproduction of quantitative and qualitative parameters of the components of the natural environment. This allows a broader approach to the definition of the socio-economic system.

7.3.1 Peculiarities of the development of socio-economic systems

A socio-economic system in a broad sense is a set of people (including relations between them), natural factors, anthropogenic material and information assets, united by the unity of the functions performed and the natural and industrial metabolism (material and information flows) functioning as a whole.

Taking into account the earlier definition of the development of systems (*irreversible, directed, regular change*) and the necessary features that determine the development processes (*self-organization through random, indefinite changes*), we can formulate the primary vectors for the implementation of the prerequisites for the progressive development of socio-economic systems (Fig. 1).

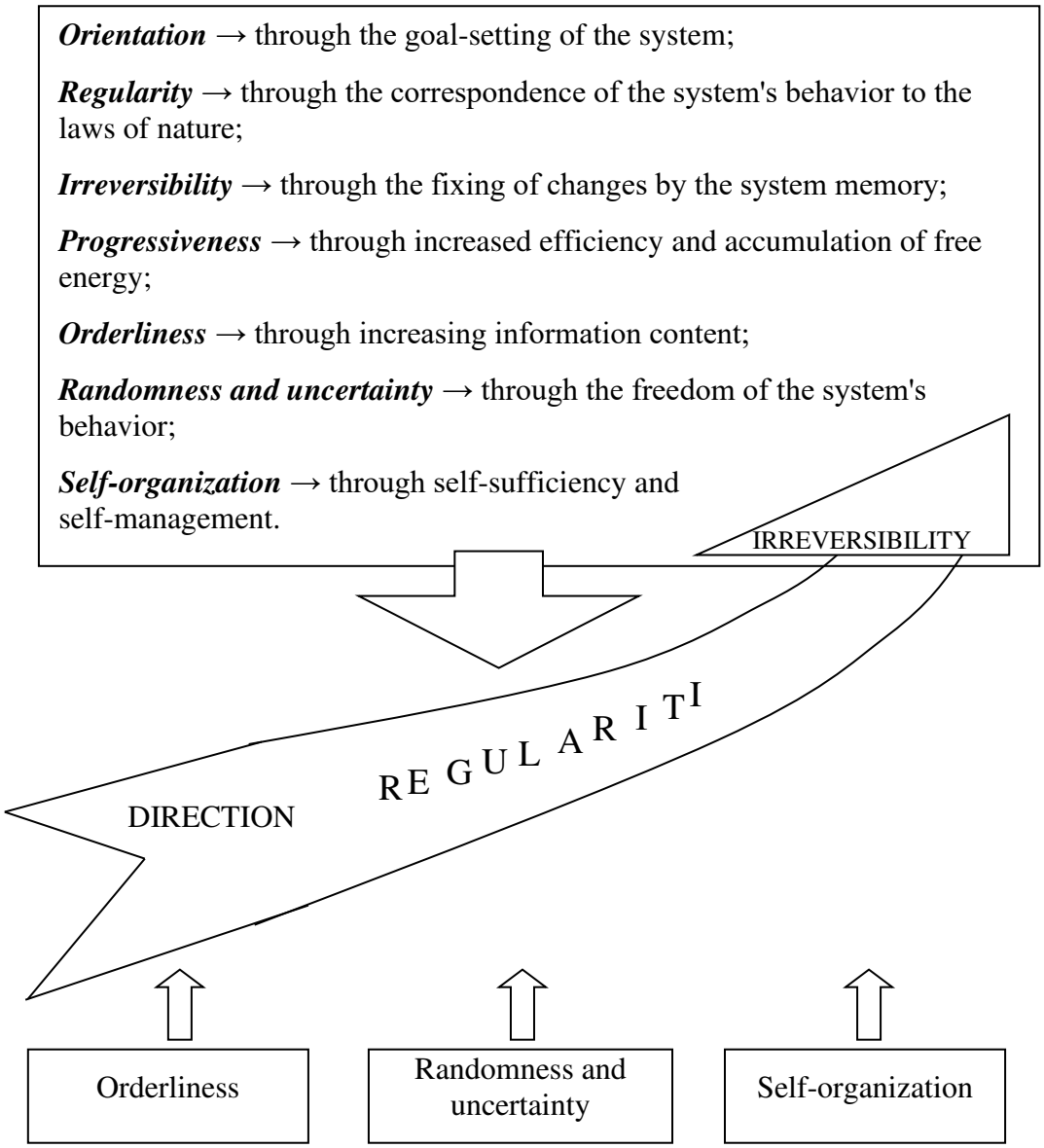

Figure 1. Scheme of formation of prerequisites for the development of socio-economic systems

This construction in a schematic form represents the substantive basis of the phenomenon of *socio-economic development*. With, perhaps, seeming excessive complexity, it cannot be simplified without losing its key semantic nodes. Each of the blocks of this construction is essential, i.e. carrying information about the content, without which the characterization of the phenomenon of development is incomplete.

The criterion of the *progressive* development of any system is an increase in the degree of orderliness of systems, which ultimately leads to a decrease in the level of entropy production by the system. The degree of order in any of the systems is

determined by three groups of factors (material and energy, informational, and synergetic). For socio-economic systems, in the criteria basis characterizing the degree of progressiveness of development, one more factor is actualized – *goal-setting*.

In general, the degree of progressiveness (P) of the socio-economic system can be expressed as a function of four main groups of factors:

$$P = f(G, M, I, S), \text{ where} \quad (1)$$

G is an indicator that characterizes the degree of approximation of the system to the planned goal (a group of goals, functions performed) or to the specifics of the organization of the system itself (those tasks for which it is "sharpened");

M is the material (quasi-energetic) potential characterizing the state of the conditionally material components of the system, which determine its ability to perform work; at the enterprise, this indicator, as a first approximation, can be quantified by the cost of fixed and working capital of production, as well as the cost of maintaining personnel;

I is the information basis of the system, the primary purpose of which is to ensure the effectiveness of the implementation of the material (quasi-energy) potential of the system; at the enterprise level, indicators for its assessment can be: capital productivity, working capital turnover ratio, labour productivity, etc.;

S is a synergistic basis that characterizes the state of relations both at the intrasystem and at the external system levels; in a formalized form, the synergetic basis can be estimated by the number of links and the cost of funds or time for the implementation of these links.

7.3.2 Approaches to the formation of a system of indicators for assessing the state of socio-economic systems

Any open stationary system is a very complex dynamic organism, the state of which must be constantly reproduced in space and time. In particular, systems as integral complexes consist firstly (in space), of material and informational elements; secondly (in time) of the system's reproduction processes. Both essential facets of the

system correspond to the formula: *the whole is greater than the sum of its parts* (in the first case – elements, in the second – *processes*).

The nature of the formation of the system as a holistic phenomenon is even more complex. The trialectic nature of the system determines the participation in the process of its formation of a number of material-informational, informational and synergistic (communication) groups of factors (goals and functions, synergistic relationships, parameters of metabolic flows, etc.) (Melnyk, 2021). Each is also a system since the same formula can be applied to it: "the whole is greater than the sum of the parts." Thus, any system in reality itself consists of a complex of subsystems. Their content can be characterized as follows:

- a system of *material and information elements* (subsystems) that form the spatial body of the system;
- a system of *goals and functions* performed by the system and its components;
- a system of *time-based processes* of reproduction of the states of the system, its components and connections;
- system of *evolution* (prehistory) of the system, including the history of systems, the predecessors of this system;
- system of *metabolic flows* and their transformations (conversions);
- a system of *information systems* that form individual components of the system and their memory systems (i.e., material and information components that ensure the accumulation, consolidation and reproduction of information);
- system of *intrasystem and external system communications*;
- a system of *constraints* (spatial, temporal, resource, etc.) within which the system must exist and develop;
- system of *environmental factors* (natural ecosystems, social systems, man-made infrastructure, climate, space factors, etc.);
- a system of *driving forces* (needs, contradictions, motivations) that ensure the desire of the system (and its elements) to function and develop;

• a system of *mechanisms* that ensure the stability of the state of the system and its variability (feedback mechanisms, transformation mechanisms, evolutionary mechanisms);

• a system of *organizational principles* for the functioning of the system and its self-organization (Melnyk, 2016).

The listed system complexes do not yet exhaust the entire variety of essential facets that form the process of reproducing the system's state. In particular, other systemic complexes within which the system functions are essential for socio-economic systems: the system of *rights and obligations*; system of *public institutions*; system of *factors of the social* environment, etc.

7.3.3 System of indicators characterizing the dynamics of socio-economic structures

Any open stationary system is not only a spatial *object* (consisting of individual components) but also a *continuous process* (consisting of separate sub-processes running in parallel and sequentially, i.e. its partial periods or phases). Therefore, the definition of a system (as a whole, greater than the sum of parts) must fully take into account the spatial and temporal aspects of the system's reproduction.

When it is said that a system is formed during the interaction of its various elements (parts), it is most often assumed that these elements are different parts of space that carry out coordinated actions in a single time continuum. This means that at each of the points in time of the period under consideration, the elements simultaneously carry out joint activities (each – his own).

However, this is only part of the truth, which is much more complex and complete than what has been said. After all, we can talk about *a system of different states* of the same system or its element, fixed at other points in time.

Thus, any *process of reproduction of the system's state* should also be considered as *a whole, greater than the sum of the individual sub-processes* of which it consists. This, in turn, means that any of the sub-processes, torn from the rhythm of the general process of system reproduction, completely or partially loses its functional orientation

and hence the meaning of its implementation. The same applies to the results obtained during such a sub-process.

Time parameters are indicators that characterize the quantitative and qualitative aspects of implementing individual processes (subprocesses) of system reproduction. Among the main ones are:

- *sequence* (order of alternation of subprocesses of changing the state of the system);
- *duration* (time period from the beginning to the end of a certain process);
- *rate* (degree of rapidity of changes in the state of the system - the time during which a conventional unit of changes in the state of the system occurs);
- *speed* (number of system state changes per unit of time);
- *the level of synchronism of processes* (the degree of simultaneity of processes in relation to each other);
- *switching time* (the period of time required for the system to switch from one process to another).

For some reproductive processes, all of the above factors are equally significant. For others, only a few.

In addition to these indicators, another one can be proposed that links time parameters with the results of changes in the system's state – the "density" of time.

"Density" of time is an indicator that characterizes the result of a change in the state of the system for a specific interval (unit) of the total period of time, including both the time of purposeful (productive) activity of the system and the time that the system needs for work breaks, switching between individual operations, transformations its homeostasis level.

The *strategic* aspirations of the system to increase the level of its efficiency and the attempts to intensify the time parameters associated with this steadily should be harmoniously linked with the *tactical* tasks of maintaining its *stationary* state, which actually "feeds" the system, being a source of *free energy* (quasenergy) entering it. The reality is that there is always a need to choose between future benefits and current

needs; strategic and tactical goals; efficiency and stability; risk and security; "Pie in the sky" and "A tit in the hands".

The control of time parameters is inevitably associated with the search for a compromise between strategic goals and tactical tasks, attempts to find a balance between two groups of factors: "compression" of time and ensuring stationarity, which is schematically shown in the diagram (Fig. 2). In this case, the third group of factors determining the period and rate of wear of individual subsystems and the system as a whole must be considered.

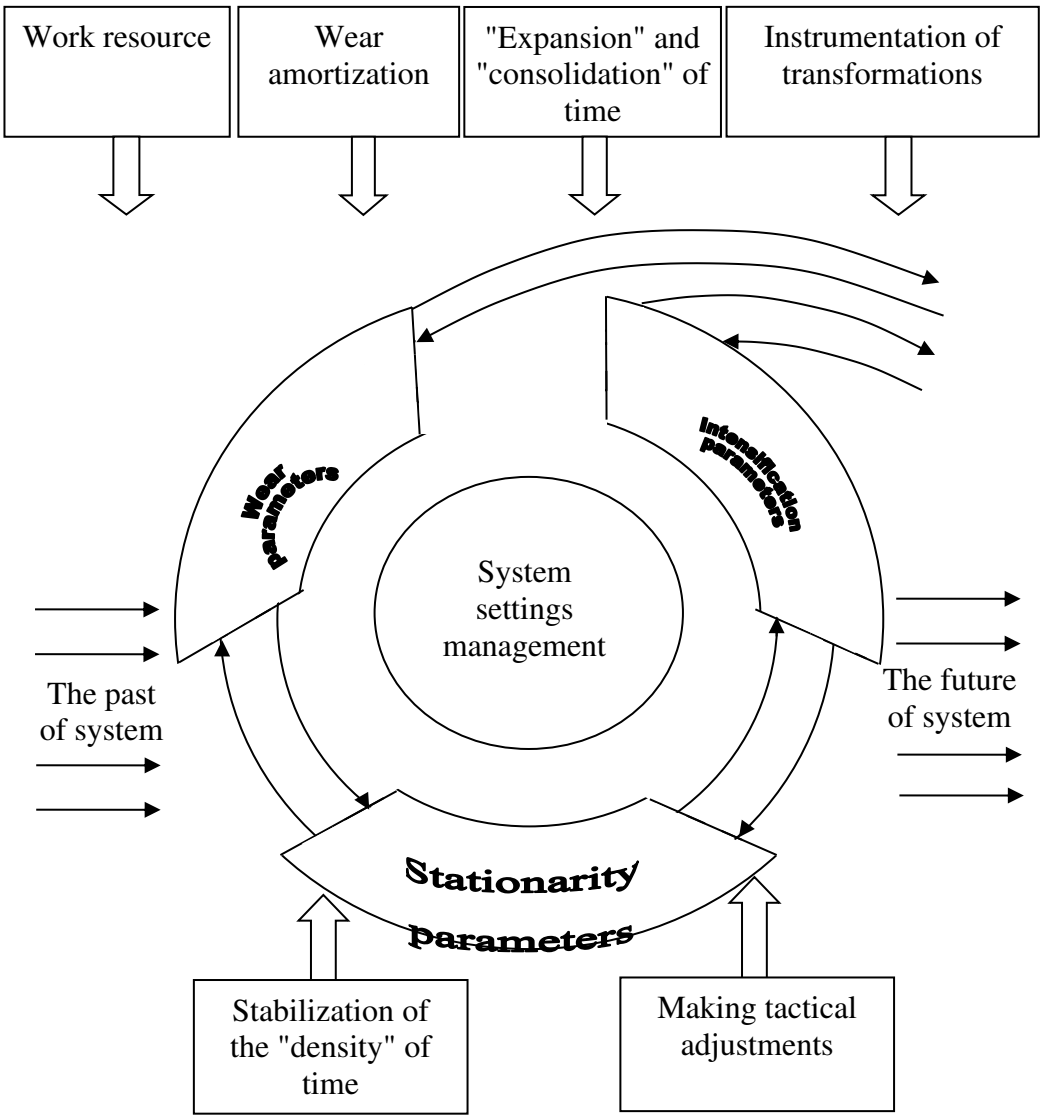

Figure 2. Scheme of managing time parameters within the economic system

Significant opportunities exist to "compact" the time of implementation of modernization transformations. Here, the most promising areas are associated with maximum *virtualization* and *instrumentalization* of transformational processes. The first is related to the maximum transfer of work related to the substantiation, preparation and transformation of the system to the virtual one, i.e. computer level. The second direction involves the maximum unification (according to the "transformer principle") of transformational technologies.

7.3.4 Conversion of systems parameters

The performed analysis allows us to conclude that the development of any socio-economic system is a complex process, where the mutual conversion of various groups of factors is constantly taking place.

In particular, examples of key conversions in economic systems can be given:

✓ *goals* are converted into *means*, and *means* - into the *achievement of goals*;

✓ *goods* are converted into *money* (when they are sold);

✓ *money* – into *goods* (for example, when acquiring the necessary raw materials);

✓ *price* – into *the volume of sold goods* (the cheaper the price, the greater the volume of goods can be sold);

✓ *sold goods volume* – into *price* (an increase in sales volume allows to reduce the unit cost of production and the selling price);

✓ *time* – into *the price* (the longer the period for the implementation of services, the cheaper it allows you to implement the service);

✓ *price* – into *time* (the cheaper the product is sold, the faster it can be sold, or: the longer you can stay on the market, selling your products and services, creating the prerequisites for increasing sales);

✓ *technology* – into *goods* (the more perfect the technology, the higher the quality of the goods and/or the cheaper the cost of its unit);

✓ *quality* – into *price/sold goods volume* (the higher the quality of the goods, the higher the price and/or more quantity it can be sold);

✓ *money* – into *information* (the higher the cost of technology, the higher the chances of its high information level);

✓ *information* – into *human capital* (the better and more complete the training of a specialist, the higher his professional level);

✓ *human capital* – into *information* (the higher the qualification of the personnel, the more perfect the technologies that he can create and/or maintain, as well as the better the products that he can produce);

✓ *information* – into *connection* (the more perfect the information algorithm of the functioning of the company, the more complete and better the internal and external relations);

✓ *communications* – into *information* (the more complete and better the communications, the more coordinated the work of the subsystems of the enterprise, and the more valuable information about the markets for raw materials and sales of products it has);

✓ *communications* – into *time* (the more coordinated the work of the performers, the less time is lost in the manufacture of products; the more reliable and better external communications, the faster the issues of supply and marketing of products are resolved);

✓ *some types of capital* – into *others* (for example, money into production assets and vice versa).

Thus, in economic processes, there is a constant mutual conversion (transformation) of various factors: *money, materials, energy, time, information, labour, and connections*. This complex, the multi-stage process takes place constantly in space and time while the economic system is functioning.

7.3.5 Indicators of sustainability of socio-economic systems

In addition to indicators characterizing the change in the *quality of the system's state*, another important indicator is its *stability* over time (Vitro et al., 2017). The sustainability of socio-economic development is due to the nature of the reproduction processes of the state of the three basic systems: *economic*, *social* and *environmental*

(García-Muiña et al., 2021). Each process is determined by its time parameters: speed, pace, and cycle.

Economic sustainability implies the stability of the economic performance of the system (Zhong et al., 2021). Outwardly, this is manifested by a *non-decreasing growth rate* of indicators that reflect the quasi-energy state of the system (income, profit) over time: from year to year, from generation to generation (Melnyk et al., 2021). This is hindered by a number of circumstances: physical and moral depreciation of fixed capital, crises of overproduction, obsolescence of manufactured products, growth of dissipative costs in the case of frequent transformations (bifurcations), degradation of human and social capital (causing a decrease in labour productivity, an increase in corruption costs, etc.).

Social sustainability implies relative stability and security of the population's life, continuity of generations, high quality of life, conditions for the existence of stable families, guarantees of a happy life for people in any of the periods of the life cycle, etc.

Environmental sustainability implies the possibility of reproducing the quantitative and qualitative characteristics of local ecosystems and the biosphere as a whole due to their reproductive potential (Melnyk, 2016).

Ecosystems, like giant reactors, produce renewable natural resources and reproduce the quality of the components of the natural environment disturbed by man: atmosphere, water, and soil. In this mode, natural systems have certain reproductive characteristics: the necessary set of components and bearing capacity (ie, specific power or the amount of work they can do per unit of time). These characteristics reflect the optimal mode of operation of the "natural reactor", particularly the required period for which a unit of work can be done (a unit of natural resources is produced or the specific volume of a natural component is purified). Increasing environmental pressure on ecosystems leads to two negative consequences: first, pollution that enters nature will remain uncleaned; and second, the ecosystems will be destroyed.

Conclusion

The evolution of any system (including economic) is a holistic (systemic) unity of system reproduction processes and phenomena. Managing the entire evolutionary cycle of economic systems (rather than its individual processes) makes it possible to achieve significant efficiency in reproduction processes and accelerate the rate of development of systems. In this regard, it is necessary to move from the design of products to the design of their life cycles in all the complexity and diversity of their systemic relationships, including the phases of the completion of the periods of operation of products and technologies.

Taking into account the patterns of functioning and development of economic systems lays the methodological basis for scientifically based management. This opens up opportunities for a significant increase in the efficiency of business processes and forms the prerequisites for the transition to an information society and sustainable development.

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