Models for forecasting innovative development of the economy of resort-recreational sphere

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Abstract. In the modern word, resort and recreation is one of the most profitable industries of the economy. Ukraine has a strong resort and recreational potential, the effective development of which can bring the real economic benefits. This requires the formation of a systemic strategy for the development of such systems, an integral part of which are innovations. The purpose of the article is to analyze and develop methods for managing innovation in the resort and recreational economy of Ukraine with its further development. Innovative processes are reflected in the changes in consumption, needs and ways to meet them. In a market environment, needs come in the form of demand, and ways to meet them are mediated by the market in the form of market fluctuations. They are important for predicting the behavior of the market of resort and tourist products. As a result of the study, a model of the mixing scenario in the conditions of innovative changes and market fluctuations and the evolutionary process of development of the resort and recreational system was built. The study of the chaotic dynamics of such a system was performed; practical criteria for evaluating the location of the system in the area of chaos intersection is obtained.

Keywords: Resort and Recreation Industry, Innovation Processes, Innovation Development, Market Variability, Chaos, Chaotic Dynamics Model.

1 Introduction

In today's health economy, resort and recreation are one of the most lucrative areas of the economy. For many countries, they have become not only a constantly growing source of financial income, but also due to the attraction of millions of tourists, the infrastructure of these areas begins to develop more actively, creating new additional jobs. Ukraine has a strong resort and recreational potential, the effective development of which can bring real economic benefits. Therefore, the recreational sphere should take one of the leading places in the structure of the economy of the country, in the process of market transformation of the economy [1, 2].

However, despite the rich resort and recreational resource base and a wide network of tourism entities, Ukraine still lacks a clear modern strategy for the development of resorts that meets global and European standards. As a rule, strategies of functioning and development of resort and recreational complexes have local character and are focused firstly on the industry of rest and, only then on restoration and treatment. As a result, the level of development of the resort and tourism industry in Ukraine is one of the last in Europe, and their degree of the compliance with the environmental standards, cultural and historical heritage is quite low.

Decreased real incomes, weakened coordination of complexes, as well as lack of control over the use of natural healing resources have led to a number of negative consequences, which is expressed in a reduction in the number of visitors by more than 50%, a significant reduction in bed capacity, high prices for resort and recreational products. The result was a difficult socio-economic situation of national resorts, which for many years defined the strategy of survival as the main direction of its development. Therefore, one of the most important research area in this field is the development of models for forecasting the innovative development of resorts based on modern market requirements [3, 4]. Thus, the identification of determinants and modern mechanisms for managing sustainable development through innovation is becoming increasingly apparent.

Trends in world economic development show that currently more than half of the gross domestic product is produced in the services sector. More than 40% of direct investment in the world economy is accounted for by trade, banking and financial services, the resort industry and tourism. World practice shows that the resort and tourism industry in terms of profitability and dynamic development is second only to the extraction and refining of oil and gas. According to the World Tourism Organization (UNWTO), the resort and tourism business provides 10% of the turnover of the services market, it accounts for 7% of total world investment and 5% of all tax revenues [5]. Therefore, the national resort and tourism sector should be considered as one of the main components which fills the budgets, which will contribute to the development of innovation processes, the creation of new resort and tourism products and technologies.

The high level of competition in the market of resort and recreational products, the need for qualitative changes in the organization of management to meet consumer demand more flexibly, the need for modern recreational products and increase the level of service, require Ukrainian resorts to expand innovation, which is aimed at optimal development of recreational potential and will allow to create a strategy of regional innovative development and the domestic industry of resorts and tourism [6].

2 Literature review

The problem of innovative development of economic systems has deep foundations in the general economic theory. It is directly related to the problems of formation, development and change of economic systems, which have been studied in the works of many scientists over a long period of time. In the process of studying the innovative development of resort and tourist systems, the authors relied on theoretical developments contained in the works of P. Drucker, R. Solow, J. Stiglitz, J. Tinbergen, J. Schumpeter and other scientists [7]. Among the researchers who pay much attention to the effects of the relationship between innovation and market components of economic processes should be noted J. Keynes [8] and J. Hicks [9], as well as J. Muth [10], R. Lucas [11], A. Strickland, R. Toaster, J. Johnson [12].

Let’s consider the main scientific and practical approaches to the development of models of innovative activity, which have become widespread today.

The result of the first attempts to describe the innovation process was the emergence of a linear model that represents the process as a sequential passage of stages of basic researches, applied researches, design, production and subsequent diffusion of innovations [13]. This model greatly simplified the innovation process, which, in fact, is not linear. However, the model continues to exist and is widely used. Its popularity is due to the fact that it clearly reflects the relationship between research work and launching of a new product in the market.

As a result of further research on innovation activity, W. Abernathy and D. Utterback proposed a model that reflects the close relationship between innovation (the final product), the innovation process and the company's strategy [14]. The dynamic innovation model combines a product life cycle model, a process life cycle model and various competitive strategies. In the development of the whole system, the authors identified three phases, each of which has different effect on individual companies, the market and the resources needed to create innovation. Fast-growing companies can go through all stages of development very quickly, and when they reach a high level of productivity, they find that their flexibility and ability to innovate has significantly decreased. Therefore, sometimes the process of product development should be frozen or even reversed. Progress cannot be stopped, but companies can put obstacles in the way of streamlining of production processes. This model helps to identify the place in the company where innovations are most effective, sources of innovation, the most appropriate type of innovation and possible barriers to innovation.

In 1985, Harvard University professors W. Abernathy and C. Clark developed a new method of innovation analysis called transilience maps. Graphically, transilience maps are presented as a matrix. Transilience maps show the possibilities of innovation to influence the company's existing resources, skills and knowledge in two different ways. The first direction focuses on how new technologies and production activities are organized, and the second direction is related to the activities required by the company to serve new markets and customers. The model identified two independent parameters of innovation, namely, technology and the market, and reflects the ability of innovations to influence the existing competencies of the company (destroy or strengthen them).

At the same time, S. Klein proposed a more complex model of the innovation processes – the chain model. The particularity of this model is the selection of five interconnected chains of the innovation process, describing the different sources of innovation and related inputs of knowledge throughout the process [16]. In his work, he draws attention to the fact that the creation of innovation by its nature is a complex, chaotic process, and therefore smooth, well-structured linear models distort the essence of the innovation process. The author considers the forces of the market and the forces of scientific and technological progress to be the driving forces of innovation. One of the significant disadvantages of the linear model was the lack of feedback. There is presence of numerical feedback in the chain model. The advantages of the chain model are the description of the variety of sources of innovation, which include the results of research (discovering new knowledge), market needs, existing knowledge (external to the company) and knowledge gained in the process of learning from personal experience.

The Stage-Gate innovation process model is a clearly structured process of developing a new product based on a concept developed by NASA, which simplifies the management of large complex projects. Many researchers have developed this concept. One of the most famous works on the Stage-Gate model was proposed by R. Cooper [17]. The model describes the process of developing a new product, which is based on a complex system consisting of successive stages ("gates" of the project). The model focuses on the decision-making process. The innovation process is seen as linear, with no possibility of returning to previous stages, but each stage is a set of parallel actions performed by interdisciplinary teams.

The Stage-Gate model represents the creation of innovations as a clearly defined process. The purpose of the model is to improve the quality of the process by dividing it into successive phases, which are adjusted if necessary. As a result, a new product enters the market earlier by eliminating unnecessary measures. The main task in the early stages is to increase the chances that the product will be commercially successful. Cooper's model provides a set of tools to manage and optimize the process of developing a new product.

In 1994, the scientific work of the English economist R. Roswell was published, which became widespread [18]. He proposed a classification of models of the innovation process. In his work, he identified five generations of models of the innovation process: the model of "technological push" (G1), the model of "market attraction" (G2), the combined model (G3), the model of integrated business processes (G4), the model of integrated systems and networks (G5). Each model corresponded to different stages of economic development of the developed countries. He found that each new generation of models emerges in response to significant changes in the market, such as economic growth, intense competition, inflation, stagflation, economic recovery, unemployment and a lack of resources. Changing the model of the innovation process requires updating the strategy, changes in the current innovation process and the creating new market niches. To confirm the found process of evolution of models of the innovation process, R. Roswell used a U-shaped curve that reflects the inverse relationship between time and cost in the innovation process.

The linear model of "technological push" (G1) is presented in the form of a causal chain, at the beginning of which are basic research, and at the end are the production and dissemination of innovations. In this model, it is assumed that each step produces a result that is the input resource of the next step, and subsequent steps do not provide feedback to the previous one.

The linear model of "market attraction" (G2) is caused by the saturation of the market with products and the emergence of marketing difficulties. At this time, the companies' struggle for market share is intensifying, forcing companies to shift the focus from research and development to identifying market needs. In the model of "demand extraction" the impetus for the creation of innovation is the identified need, and R&D becomes a further step to meet market demands.

The combined model (G3) shows the importance of both market and technological factors. Both the results of research and the needs of the market act as a source of innovation. The model of innovation of the third generation retains a consistent linear character, but with numerous feedbacks.

New approaches to the organization of production have led to the emergence of a new generation of models of innovation processes – integrated business process models (G4). These models emphasize the importance of integration of research and development with production and closer cooperation with suppliers and customers. Different divisions of enterprises have been integrated to create a new product, allowing the enterprise to reduce product development time and costs. At the same time, horizontal cooperation (creation of joint ventures, strategic alliances) has significantly increased.

The model of integrated systems and networks (G5) focuses on the problem of resource constraints. This leads to the merging of companies into a network to ensure flexibility and maintain the pace of development. The strategies are based on the development of partnership, joint marketing, the transition to "open innovation". The approach to the innovation process has changed. The companies came to the conclusion that in order to create innovations, it is necessary to unite not only the various departments involved in the process, but also to create and strengthen their network interactions with consumers, suppliers, research laboratories, universities and other institutions. Also, this period is characterized by extensive use of expert systems, simulations, nonlinear dynamics, chaos theory.

The Funnel model was developed by S. Wilright and K. Clark [19]. It represents the creation of innovation as a process of transforming an idea from a concept to a real product that meets the needs of the market. The focus of the model is on the process of finding and selecting ideas. A large number of ideas, which are gradually processed and evaluated, are the inputs of the model. The most promising ideas will subsequently be migrated to the new product development process. Graphically, this process is depicted as a converging funnel.

The closed models of the innovation process were successfully applied in practice until the end of the twentieth century. They are based on the principle that successful innovation must be developed within the company, i.e. the company must independently generate ideas, develop them, conduct research, production, marketing, distribution and maintance of goods.

Recently, the open model of innovation has become more widespread. The theory of open innovation defines the process of research and development as an open system. To create innovation, a company can use a variety of sources of ideas. It should use both its own research and research conducted by other organizations in the process of development of innovation. If the identified innovation does not correspond to the business model of a company, it is necessary not to hide it, but to benefit from its use by other organizations through sales, distribution of licenses, creation of subsidiaries, etc. [20]. The open model of innovation belongs to the fifth generation of models according to the Roswell classification. Research on the innovation process is currently mainly related to the development of an open model of innovation, the various methods and tools used in this model, as well as the specific features of it in different countries.

The cyclical model of innovation [21] demonstrates that the successful launch of a new product or service is a nonlinear process involving many cyclical interdisciplinary interactions between process participants. The cyclical model aligns the "technology push" model with the "demand extraction" model. The model is a closed loop, which includes four nodes of change, combined with four interacting cycles. Together, they form the basis of a complex innovation process that crosses the boundaries of traditional companies and corresponds to the modern model of open innovation. Since the innovation process is a closed cycle, it is impossible to say what is at the beginning and what is at the end of the process - science or market. The innovation process can start anywhere at any time. Changes that occur in one node cause changes throughout the cycle.

One of the main models of innovations is the diffusion model of their spread. According to it, the spread of innovations depends on both the number of firms that have already implemented innovations and the number of firms that have not yet mastered them. The lack of a diffusion model to describe markets is due to the fact that in different areas of the economy coexist technologies with different efficiency. Moreover, the curves of power distribution of any sphere on the levels of efficiency for different points in time are similar to each other. Thus, we can talk about the universality of the "spatial" curve of technology distribution, its stability (invariance) over time.

At the same time, this fact contradicts traditional economic theories, according to which capital investment should be made only in the most efficient (profitable) technologies, and therefore the share of low-profit production should be quite small or at least it should decrease over time, as provided by traditional diffusion model. To eliminate this contradiction V.M. Polterovich and G.M. Henkin proposed an evolutionary model of the interaction of processes of technology creation and borrowing, which allowed to connect these two facts - the logistical nature of diffusion "time" curves of technology spread and a stable form of "spatial" curves of production distribution by efficiency levels. They showed that this situation is two sides of a single mechanism of "dynamic balance" between innovation and simulation processes [22]. The simulation results showed that a turbulence scenario appears under certain conditions of innovation diffusion, which is similar to the equation of J.M. Burgers [23], and, as a consequence, there is the phenomenon of self-organization.

3 Methodological aspect research of management of innovative processes in the system of resort-recreational sphere

New methodological principles for the study of innovative development of the resort and recreational industry should take into account the factors of instability and complexity of the modern market economy. Recently, there has been a growing scientific interest in new areas in economic theory, which explore the problems of interaction of linearity and nonlinearity, stability and instability, equilibrium and chaos [24]. Nonlinearity and instability are considered as sources of diversity and complexity of economic dynamics. This concept focuses on such aspects of dynamic economic systems as nonlinearity, instability, bifurcation, chaos.

Of particular interest in the context of innovation development is the chaotic dynamics that arise in the process of diffusion of innovations. From the point of view of the theory of evolution, chaos is a natural stage that allows a system to correct its own shortcomings, when its elements are desynchtonized. When the connection between the elements of the system weakens and their functions and positions in the hierarchy of the system change, it has the opportunity to conduct self-organization on the basis of information known about existing internal and external problems. If chaos as a period of transformation was absent in the system, then any constructive changes in it met with high resistance of its elements, for which the current state of the system is favorable. In this context, periods of chaos in the economy can be seen as effective bifurcation points, in which there is a transition of the economy to an innovative path of development in times of crisis.

Significant technological shifts in socially significant areas often lead to poorly predicted socio-economic consequences, being periods of poorly managed innovation chaos. Let's introduce the following definition of such a process: innovation chaos is a period in time and space during which fundamental transformations in economic, scientific and technological spheres take place, which are caused by new scientific discoveries and innovative directions of development. In the process of innovation chaos, the investment potential of the respective markets significantly increases. Thus, it is very important to model the processes of emergence and functioning of innovation chaos as a way to ensure maximum socio-economic effect for the development of the national economy in general and the resort and recreational economy in particular.

It should be noted that the ability to self-organize is also an important characteristic of complex resort and recreational systems. This property means the possibility of arbitrary ordering of the internal structure of the system, which is manifested in the establishment of distant correlations between its elements, i.e. increasing the rigidity and range of connections. The resort system, on the principle of saving internal resources, strives for an equilibrium state with the maximum level of disorganization, depending on the external actions that the system is forced to resist. Accordingly, the stronger the external actions, the stronger should be the interconnected elements of the resort and recreational system and the higher its level of self-organization. Under the influence of external anti-entropy actions in the process of self-organization, the structural connections within the system increase their range and rigidity, thus generating flows of negative entropy for their elements. And those, in turn, either increase the level of their own organization, or collapse, producing an increase in entropy. Having reached the maximum rigidity of relations, the resort-recreational system acquires the properties of self-organized criticality. In this state, the system is most sensitive to all external and internal influences. Even the slightest fluctuations can cause a bifurcation process in such a system and lead to the destruction of the formed structure, after which a new cycle of self-organization begins.

The cause of the fluctuations that give rise to self-organization is the intersection of several chaos. External fluctuations occur due to negative entropy connections from macrosystems. Internal fluctuations are caused by deterministic chaos, which, resonating through the rigid connections of the elements of the resort and recreational system, passes to higher levels. Further, due to tight structural ties, these fluctuations intensify and move to higher levels of economic development.

At the heart of self-organization is the desire of resort and recreational complexes to provide a variety of reactions, adequate to the variety of external influences, in which the system will be able to implement the adopted strategy to achieve goals. And the growth of internal entropy is ensured by the use of the positive effect of scale and the internal relationship of the types of resort and recreational activities, thereby reducing the cost of resources to ensure the effectiveness of external strategy. Thus, the main components of the functioning of resort and recreational systems are optimized. It can be argued that the adaptive behavior of the resort and recreational system, its structure and management are formed at the intersection of two types of fluctuations: internal innovation and external market variability. This is a manifestation of the intersection of several chaos, on the verge of which there is self-organization.

Innovation as a kind of chaos can be a stimulus and a mechanism for entering to one of the possible trajectories of development, that corresponds to the internal trends of the resort and recreational system, which ensures its new quality. This is the essential importance and constructive role of innovative factors for launching self-organization processes in the system and preparing it for different development scenarios. Innovation, as a kind of chaos, is a factor that brings nonlinear systems to their own structure of attractors.

Since innovations are an element of chaos in relation to the existing resort and recreational system, their implementation causes a process of self-organization in the system, aimed at adapting a new element to the structure. To accelerate its adaptation, the recreational system produces internal relevant innovations, the relationship between the elements complicates, the structure of the system changes. At the first stage of self-organization to ensure the stability of the system, the number of its reactions (internal innovations) must correspond to the number of external signals due to the presence of market fluctuations. The system builds a structure in which each external action corresponds to an element capable of generating internal innovations and influencing changes in the structure of the system.

At the next stage, the resort and recreational system is evolving in the direction of an increasingly orderly state, which is achieved through a hierarchy of elements: the parameters of order are set, the principle of subordination is included, effective grouping of homogeneous internal innovations is ensured, which allows to adapt with the least changes in the structure of the system, and therefore with the least cost. In other words, at this stage there is an adaptation of the resort and recreational system. The system is in a state of persistent imbalance, and endogenous innovations that promote rapid adaptation and self-organization are crucial.

The resort and recreational system selectively responses to exogenous innovations, setting a strict regime for their penetration, perceives only the influences that correspond to its nature, any other influences can have a negative effect until the implementation of chaos scenarios. Having reached a certain degree of internal strength, nonlinear systems are activated, they structure the external space in accordance with its immanent nature and the existing market environment. At this stage, it is necessary to develop an appropriate management paradigm that would develop appropriate goals and include adequate internal mechanisms for the development of the resort and recreational system. Thus, the property of innovation can be considered as a interruption of the usual order of functioning of the recreational system. The order can be aggressive, it seeks to suppress any manifestations of the new elements in the system, including innovation as a form of chaos. Contradictions, conflicts and economic failures that accompany the development of a complex resort and recreational system may be associated with this.

The processes that take place in the market environment have a different nature. The transition economy, which is in the process of systemic transformation, is characterized by: qualitative and quantitative change of components (deformation and extinction of some and the emergence of others); the plurality of states that are qualitatively different from each other; nonlinearity of development trajectories due to the rapid change of states. There is a different inertia of the components and the market environment in general in the process of transformation, which indicates that the time during which trends persist has different durations. Components of the market environment of a subjective nature are also subject to changes: there are changes in the needs of subjects, their interests, motives, stimulus-reactions and behavior change. This led to increased chaos, disagreement, spontaneity of relationships and increased market fluctuations in a market transition economy. Thus, the market environment can be considered as a synthesis of spontaneous market evolution and cyclical and chaotic changes.

The above allows us to state that the functioning of the resort and recreational system in the intersection of deterministic chaos is determined by significant features. The impact of innovation and external market chaos on the economy of the resort and recreational system leads to the deformation of its nature. Its chaotic component is significantly enhanced, cyclicity is significantly modified, in particular, the phases of the cycle are deformed. Loss of stability of the resort and recreational economy in conditions of uncertainty and permanent crisis bring the system into a mode of bifurcation development, which is characterized by frequent changes in the direction of movement. As a result, abnormalities are observed in their behavior, in particular, the effect of mixing and the emergence of hyperchaos.

4 Methods and results of research

Let’s consider one of the scenarios that arises in the innovative activities of the resort and recreational system in the intersection of deterministic chaos on the basis of the following model.

$$\frac{dx}{dt} = kx + y - xS,$$

$$\frac{dy}{dt} = -x,$$

$$\frac{dS}{dt} = -\varepsilon S + \varepsilon R(x,y)(x+y)^n, \tag{1}$$

$$r(x,y) = \begin{cases} 1, (x,y) > 0, \\ 0, (x,y) \leq 0' \end{cases}$$

$$\frac{dx}{dt} = kx + y - xS$$

where x – production of an ordinary resort and recreational product; k – parameter that takes into account the growth of product production; y – production of an innovative resort and recreational product; S – market fluctuations in demand for resort and recreational products; ε – demand inertia parameter; $R(x)$ – market fluctuation indicator;
$n > (3/2)te^{-ut}$ – the place of moving to the edge of chaos.

The results of computer simulation are presented in Fig. 1.

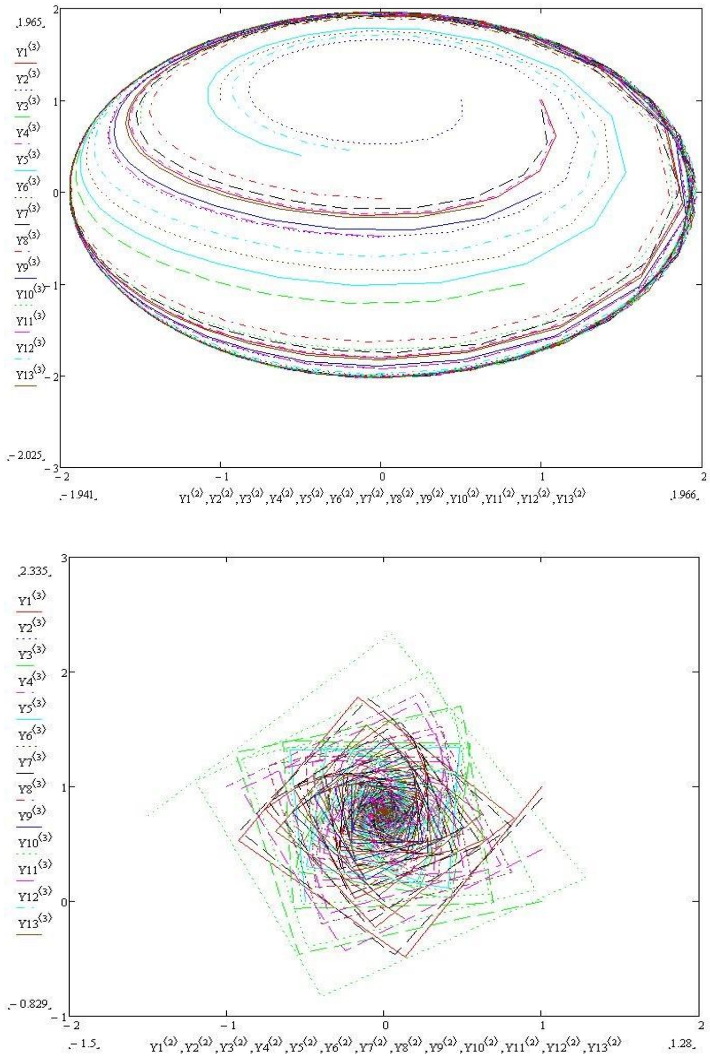

Fig. 1. Mixing of phase trajectories in the conditions of intersection of deterministic chaos

Let's introduce the following definition: $f: X \to X$ is topological mixing, if for any two open nonempty sets $U, V \subset X$, there is such a positive integer $N = N(U, V)$, that for each $n > N$ intersection $f^n(U) \cap V \neq 0$. This means, that for any given $\theta > 0$ and nonempty open set U all iterations U with a large number turns out to be θ-dense in phase space [25].

The unpredictability of the behavior of the resort and recreational system in the conditions of intersection of deterministic chaos is associated with the instability of the system regarding small deviations of the initial state. This means that it is necessary to analyze the evolution in time not of the starting point, but of the initial volume around this point.

Let’s consider a small sphere of radius $\theta > 0$, that surrounds the initial state x_0. Any point inside the sphere characterizes a small deviation from the initial state. Let's apply the time-evolution operator and look at the transformation of this small volume over time. Under the action of the deterministic law of evolution, the sphere of radius θ in time will be compressed and at $t \to \infty$ its radius will be decreased to zero. Thus, if the resort and recreation system is stable, then any small deviation will eventually fade and the system will return to its original mode.

The instability of the state leads to an increase in perturbations. At the same time, if the system is dissipative, there is a decrease in the element of phase volume over time, which is associated with economic losses. This means that the element of the phase space is stretched in some directions (which corresponds to the positive indicators of Lyapunov), and in others – is compressed. Moreover, the degree of compression prevails over the degree of expansion. That is, any small deviation of the initial state can be detected in any part of the phase space, which results in mixing in the entire region of the trajectories.

The main cause of mixing is the instability of trajectories due to the intersection of deterministic chaos. This means that a small perturbation of the state must increase exponentially over time.

$$Q(t) = Q(0)e^{\lambda t}, \lambda = \lim_{t\to\infty} \frac{1}{t} \ln \frac{Q(t)}{Q(0)} \tag{2}$$

Where λ – Lyapunov index. The positive value is proof that the mixing scenario is implemented in the system. Thus, if the simulation results show that the studied economic process has a positive Lyapunov index, the consequence will be: non-periodicity of any state parameter and autocorrelation function, which decreases over time.

Thus, in the case of a mixing scenario in the innovative activities of the resort and recreational system, it is possible to predict the future state only in the case of a clear assigning initial conditions. However, given the small, but final error, a deterministic prediction becomes impossible. The small region of primary uncertainty is blurred by mixing to the final region in the phase space. This behavior of the basic parameters of the system is clearly associated with the idea of a random process. The studies show that a process generated by deterministic laws, in particular the intersection of deterministic chaos, may have similar properties.

It should be noted that innovations perform a special function in the reconstitution system – the function of generating changes, they are a source of self-development and self-organization of resort and recreational systems, and they are an important internal process and structural element. To quantify the actions of the reconstitution system, in terms of the existence of input effects, we need to introduce the objective function of the system

$$F: X \times S \times Y \to P \tag{3}$$

where, $X = \{x_i\}$ – system resources (including innovations); $S = \{s_i\}$, $i = \overline{1, N}$ – internal states of the system (production); $Y = \{y_i\}$, $i = \overline{1, N}$ – production and sale of resort and recreational products; P – profit function.

If P has more than one component, then $P = P^r = x\{P_i,\ i \in I_r\}$, where $I_r = \overline{1, N}$ – number of components (multicriteria system). Let's present the objective function in the form of two functions: the original $W: X \times S \to Y$ and the function (3). Then

$$G(x,p) = F(x,p,W(x,p)) \quad (4)$$

The functional of the equation 4, which describes the operation of the whole system, is an efficiency functional. Real reconstitution systems usually have several purposes and consist of a set of subsystems. Let's define the local target functions of subsystems as $f_i: X_i \times Y_i \to P,\ i \in I,$. Then the functional 4 can be written as $G(x,p) = G(f(x), P)$, where $f(x) = \{f_i(x),\ i \in I\}$ – quality indicators of subsystems.

Uncertainty is a fundamentally integral part of the innovation process, as innovation is inextricably linked with the struggle between the old and the new. Under uncertainty, the choice of optimal values of system parameters can be carried out as a task of finding satisfactory solutions: you need to find such $\tilde{x} \in X^{\delta}$, that $\forall_p \in S$,

$$G(\tilde{x},p) \geq \varphi(p) \quad (5)$$

where $\varphi(p)$ – a function that determines the minimum allowable value of the objective function.

It should be noted that the set S covers both parametric and structural uncertainties, i.e. in fact, it is the set of all factors influencing the solution of problem (5). It should be noted the most important task in the problem (5) is finding a function $\varphi(p)$, which determines the minimum or allowable quality of the system at any manifestations of uncertainty $p \in S$. Function appearance of $\varphi(p)$ depends on both the properties of the function $G(x,p)$, and the type of uncertainty, which takes place depending on the stage of the innovation process. However, uncertainty can be reduced to three main types:

$S^{\langle 1 \rangle}$ – the set of uncertainties due to the internal and external environment and their interaction. This type is chaotic in nature and is modeled by the methods of chaos theory and catastrophe theory;

$S^{\langle 2 \rangle}$ – the set of uncertainty, which is due to purposeful counteraction (competition of systems). It is modeled by methods of game theory;

$S^{\langle 3 \rangle}$ – the set of uncertainties associated with description inaccuracies that cannot be estimated statistically. It can be described by methods of fuzzy set theory.

Thus, the solution of the problem of extended reproduction in the conditions of innovative resort-recreational economy can be obtained on the basis of the model of multicriteria optimization taking into account the above relations.

5 Conclusions

The study of the behavior of the resort and recreational system in the face of innovation and market variability allows us to draw the following conclusions.

The study of the role of innovation in the formation of an innovative concept of economic development of the resort and recreational industry allows us to highlight the importance of the influence, that is able to push the system to one of the development paths favorable to it and start the process of self-organization in times of instability. Thus, the most important role of management in times of unstable and crisis situations is to effectively use the chaos and push the system to develop in an innovative way.

From the standpoint of unbalanced dynamics, the behavior and development of systems is interpreted as a sequence of transitions in the hierarchy of structures of increasing complexity. The transition to a new level of life goes from chaos to order through instability. In unbalanced situations, the emergence of order is possible only in the presence of external flows that keep the system far from equilibrium. Dissipative destruction of the structure and dissipation of energy or information develops in the absence of these flows, resulting in systems degrading to a balanced state. Interaction with the environment creates potential opportunities for the emergence of unstable states and the emergence of a new, more orderly structure.

The instability that arises in the process of development creates the possibility of an abrupt transition of the system to a new state. The jump can be considered as a reaction of the system to the perturbation in order to compensate for it. However, the system does not return to the old state, but passes to a new innovative state, i.e. "development through instability" provides stability at a higher level. In this case, the stability itself is understood not as the stability of balanced structures, but as the dynamic stability of open systems at the expense of self-organization and self-regulation, carried out mainly through transformations.

For citations of references, we prefer the use of square brackets and consecutive numbers. Citations using labels or the author/year convention are also acceptable. The following bibliography provides a sample reference list with entries for journal articles [1], an LNCS chapter [2], a book [3], proceedings without editors [4], as well as a URL [5].

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