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INNOVATIVE AND INVESTMENT DEVELOPMENT OF RESORT CITIES AND DESTINATIONS: SUSTAINABLE DEVELOPMENT MODELLING

ZAKHARCHENKO Pavlo[1], NESTORENKO Tetyana[2], KOINASH Maryna[3]
[1] Berdyansk State Pedagogical University
https://orcid.org/0000-0001-5025-797X
e-mail: pvzz1957@gmail.com
[2] Berdyansk State Pedagogical University
https://orcid.org/0000-0001-8294-6235
e-mail: tp_nestorenko@bdpu.org.ua
[3] Simon Kuznets Kharkiv National University of Economics
https://orcid.org/0000-0002-7843-5595
e-mail: m.timofeeva@ukr.net

The article examines the specifics of innovative development in resort cities and destinations in the context of transformational processes in the global economy and the development of a platform economy. It considers current trends in the innovative evolution of the sector, including digitalization and the implementation of advanced technologies to enhance the quality of recreational and tourist services. Taking into account the concepts of J. Schumpeter, G. Mensch, A. Kleinknest, and other researchers, the study analyzes the impact of innovations on economic cycles, structural changes, and the competitiveness of resort and recreational cities and regions. Special attention is paid to the role of innovation waves that form new business models and alter the economic landscape of the industry.

A mathematical model for selecting the optimal innovation policy is proposed, which is based on the analysis of the effectiveness of investments in state-of-the-art recreational technologies. A generalized logistic equation is employed to model the dynamics of technological changes, enabling the forecasting of the effectiveness of innovation implementation and its impact on the sustainable development of regions. The criteria for assessing innovation processes are defined, namely, their economic feasibility, environmental safety, and social significance. The necessity of integrating platform solutions to enhance the adaptability of the resort and recreational economy is demonstrated.

The study also explores the possibilities of applying digital ecosystems and algorithmic management for coordinating innovative activities and optimizing resource allocation. The regularities governing the interaction between innovation waves and economic processes – which ensure the long-term stability of the development of resort cities and destinations – are identified. The proposed innovation management model allows for evaluating the effectiveness of various development strategies, contributes to the formation of competitive business models, and ensures sustainable growth in the resort and recreational sector.

Keywords: resort cities and destinations, sustainable development, platform economy, modeling, innovations, investments.

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INTRODUCTION

The innovative dimension of the development of the resort and recreational sector is gaining particular importance amid the transformation of the global economy, which necessitates the implementation of new conceptual approaches and a methodological toolkit based on systems analysis and the modeling of economic processes. In the context of ensuring sustainable development and building a platform economy, the key task is to create innovative mechanisms for integrating digital technologies that will enhance the efficiency of regional resource potential utilization.

LITERATURE REVIEW

The development of resort and recreational cities and regions in the context of sustainable development and the platform economy requires the incorporation of both innovative and investment aspects. The very term "innovation" as an economic category was first proposed by J. Schumpeter [1], who examined the impact of new combinations of production factors on economic dynamics and identified five key directions in the evolution of innovation processes. Subsequent research into the interrelationship between innovations and the cyclicality of economic development was conducted by the German economist G. Mensch, who developed the concept of "fundamental innovations." According to him, the exhaustion of the potential of such innovations leads to technological stagnation, and the resumption of economic growth is possible only through the implementation of radical changes [2]. He also justified a classification of innovations into fundamental, incremental, and pseudo-innovations, which allows for the assessment of their impact on the dynamics of economic cycles.

The conceptual foundations of innovative development are elucidated in the works of A. Kleinknest [3], R. Coomns [4], C. Freeman [5], and other researchers who emphasize the role of innovations in the structural transformation of economic systems. In analyzing the processes of scientific and technological progress, these authors underscore the importance of institutional support for the commercialization of innovations as a means to achieve economic growth.

In study [6], the authors investigate the development of Ukraine's smart industry, which is of significant importance for the implementation of digital technologies in resort cities and destinations. They emphasize the role of digital platforms in ensuring sustainable development and effective resource management. The findings from the study on the innovative potential of industrial enterprises [7] can be applied to the resort and recreational sector to enhance its competitiveness through the activation of innovation processes and the adoption of platform-based solutions. Dubovyk and Havrylenko justify the necessity of stimulating small and medium-sized enterprises [8], which are crucial for resort cities, as these businesses support the development of tourism infrastructure and job creation. Moreover, an analysis of various approaches to defining business models [9] is essential for devising effective management strategies for the resort and recreational economy and for attracting investments.

To understand the impact of external factors on the development of resort and recreational cities and regions, it is important to analyze the constraints and opportunities for entrepreneurship under conditions of armed conflict and the pandemic, as well as the role of digital technologies in this context [10, 11]. Several studies emphasize the importance of investments and the modernization of resort infrastructure in ensuring long-term sustainable development [11–13]. In study [14], innovative and investment processes in the resort and recreational economy of Ukraine are examined, with particular emphasis on the need to model sustainable development and implement platform technologies.

The analysis of the aforementioned sources confirms the significance of innovative and investment strategies for the development of resort and recreational cities and regions. The advancement of the platform economy and digital technologies in this context plays a vital role in enhancing competitiveness and managing resources effectively. The application of modeling techniques allows innovations to be viewed as a process of natural selection of effective business development strategies, thereby contributing to the formation of self-regulating economic systems. However, the intuitive nature of innovation processes complicates their forecasting, necessitating the development of state regulatory mechanisms to stimulate market-oriented scientific research and accelerate their commercialization.

The purpose of the study is to develop a model for the innovative and investment development of resort cities and territories under the conditions of ensuring sustainable development.

MAIN PART

Due to the high significance of innovation in this study, it is proposed to consider modeling the behavior of the resort-recreational system through the implementation of innovations. To this end, we modify the model for selecting an innovation policy by the resort-recreational system in accordance with the conditions of the innovation economy. It is assumed that the dynamics of the development of $n > 1$ recreational technologies is examined over a fixed planning horizon T, which is known. The dynamics of i technology development is described by the following differential equation:

$$x_i'(t) = \{ f_i(x_{i-1}(t_i), u_i(t) x_i(t)[P_i - x_i(t)]\} \Omega(t \geq t_i) \quad (1)$$

where $f_i(x_{i-1}(t_i)$ – the previous state of development of recreational technologies; $u_i(t)$ – the control variable, which can be regarded as investments in development; $\Omega(t)$ – the indicator function with $t \in [0;T\}$; P_i – the known boundary levels of development of recreational technologies; $i \in \{1,...,n\}$ – the set of resort-recreational technologies; $t_1 = 0 \leq t_2 \leq ... \leq T$ – the finite sequence of transition moments from one recreational technology to another.

The initial and boundary conditions will be determined from the corresponding relations:

$$x_1(0) = x_0 \geq 0, \quad x_i(t_i) = \max[x_0, x_{i-1}(t_i) - \alpha_i], \quad i \in \{1,...,n\}.$$

It is important to note that the time moments t_i correspond to the transition to a new recreational technology, while the values α_i represent the losses associated with this transition, $u_i(t_i) \geq 0$ describes the dynamics of changes in resources invested in technological development. The dynamics of i technology are modeled by a generalized logistic equation, where the growth rate is described by a function

$f_i(x_i(t_i),u_i(t))$, which depends on the previously achieved level of development $x_{i-1}(t_i)$ and the amount of resources $u_i(t_i)$. The trajectory $x(t)=x_i(t)$, $t\in[t_i,t_{i+1}]$ characterizes the dynamics of the development level of resort and recreational technologies.

Let us determine the level of technological development $X(T)$ achieved by the end of the planning horizon T

$$X(T)=\max[x_i(T)] \tag{2}$$

Let's define the revenue function $D(X(T))$, which represents the income received at the end of the planning period and depends on the achieved level $X(T)$ of resort and recreational technology development. The revenue functional $F(x(t))=\int_0^T f(x(t)dt$ then reflects the income generated during the technological development process, while $Z(u(t))=\int_0^T\sum_{i=1}^n u_i(t)e^{-\delta(t)t}dt$ represents the cost functional. Here, $\delta(t)\in[0;1]$ denotes the discounting coefficient, $u(t)=(u_1(t),...,u_n(t))$ is the resource dynamics vector reflecting the investment policy, and τ\tauτ is the vector of time moments of recreational technology changes, representing the innovation policy.

Let us introduce the following model constraints:

$$u_i(t_i)\geq z_i,\ u_i(t)=0,\ t\notin[t_i;t_{i+1}] \tag{3}$$

where the constants $z_i\geq 0$ can be interpreted as investments in the implementation of corresponding resort and recreational technologies.

The efficiency criterion can be formulated as the difference between revenue and costs. Thus, the optimization problem takes the following form: maximizing the efficiency criterion by selecting the sequence Ψ of technological changes and the resource dynamics vector $u(t)$,

$$D(X(T))+F(x(t))-Z(u(t))\to\max \tag{4}$$

provided that the dynamics of recreational technologies is described by the system of equations above with given initial conditions, and the resources satisfy the constraint.

Each of the equations included in the system can be solved independently

$$x_i(t,u_i(t))=\frac{x_i(t_i)P_i\Omega(t\geq t_i)}{[x_i(t_i)\int_{t_i}^{t-t_i} f_i(x_{i-1},u(\tau))e^{\int_{t_i}^{\tau} f_i(x_{i-1},u_i(\vartheta))d\vartheta}d\tau+P_i]e^{-\int_{t_i}^{t-t_i} f_i(x_{i-1}(t_i),u_i(\vartheta))d\vartheta}} \tag{5}$$

Under $u_i(t)=u_i$, $t\in[t_i;t_{i+1}]$ from solving the equation we obtain a set of logistic curves

$$x_i(t,u_i)=\frac{x_i(t_i)P_i\Omega(t\in[t_i;t_{i+1}])}{x_i(t_i)+(P_i-x_i(t_i))e^{-f_i(x_{i-1}(t_i),u_i(t))}} \tag{6}$$

The considered optimization model is additive since its efficiency criterion is defined as the difference between a functional dependent on the terminal value of the trajectory and a functional dependent on the entire trajectory, with transition moments being a priori ordered. Therefore, this problem

belongs to the class of optimal control problems with phase coordinates that exhibit discontinuities at internal points. In the case of fixed transition moments, dynamic programming methods can be employed to solve it.

Thus, the proposed model facilitates the simultaneous selection of both innovation policy (determining the optimal timing for the introduction of new resort and recreational technologies, including the feasibility of their implementation) and investment policy (identifying the optimal investment schedule for entities in resort and recreational cities and regions in new recreational technologies).

Based on the modeling results and the conducted analysis, the following conclusions can be drawn regarding the patterns of innovation processes both in the resort and recreational sector and in the national economy as a whole, considering the necessity of developing a platform economy to ensure sustainable development.

Periodic innovative changes represent a fundamental regularity of economic development in general and the resort and recreational economy in particular. This phenomenon is driven by several key factors. First, any economic system has its own development potential and life cycle, necessitating periodic transformations. Second, the resort and recreational sector exhibits a natural tendency toward expansion and increasing complexity, including the growth of service volumes and the differentiation of consumer needs, which must be met through the introduction of new technologies and digital platforms. Third, changes in the natural environment also influence the development of this sector, requiring adaptation of business models and a transition to more flexible platform-based solutions. The inability to adapt to change leads to crises, resulting in radical economic transformations. Innovative changes follow a cyclical pattern, leading to a phase of stable development until the potential of the current state is exhausted.

Innovation activity develops in waves, with periods of intensification and decline. In the resort and recreational economy, innovation cycles of varying depth and duration are clearly observed. During transitional stages, the emergence of fundamental innovations stimulates the flow of incremental innovations aimed at optimizing previously implemented technologies. Over time, the number of fundamental innovations decreases, but this is offset by a larger volume of incremental improvements that ensure the gradual renewal of the system. In the third stage, innovation activity stabilizes, yet its efficiency declines, leading to an increase in pseudo-innovations that aim to extend the life cycle of outdated systems. In the phase of an innovation crisis, activity levels drop sharply, while during the depression phase, the conditions for a new wave of fundamental innovations emerge, driving the next development cycle. In a platform-based economy, this process can be optimized through the use of digital ecosystems, which enable continuous information exchange among all market participants and accelerate adaptation to change.

Innovation activity is influenced by cycles of varying duration that interact both with one another and with the overall cyclical dynamics of the economy. Sustainable development conditions require the effective use of platform-based solutions to coordinate processes across sectors and enhance the adaptability of economic systems. The use of digital platforms in the resort and recreational economy fosters synergies between innovation cycles, thereby improving resource management efficiency and ensuring the sector's sustainable development in the face of global challenges.

CONCLUSIONS

In the context of the development of the platform economy and the digital transformation of resort and recreational cities and territories, the integration of innovations into strategic planning systems is a crucial factor in ensuring sustainable development. The analyzed scientific sources highlight key issues related to economic process modeling, business model development, and the impact of contemporary challenges on the resort and recreational sector. This necessitates the allocation of significant investment resources for infrastructure modernization, capital renewal, and the implementation of research and development projects. The proposed model enables the assessment of managerial decision-making efficiency regarding the introduction of new technologies in the resort and recreational sector, the determination of optimal moments for technological change, and the allocation of resources to ensure sustainable development. Thus, the innovative development of the resort and recreational sector should be based on the concept of the intellectualization of economic processes, which will allow for the creation of a synergistic effect from the implementation of digital technologies and the development of competitive business models.

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ІННОВАЦІЙНО-ІНВЕСТИЦІЙНИЙ РОЗВИТОК КУРОРТНО-РЕКРЕАЦІЙНИХ МІСТ І ТЕРИТОРІЙ: МОДЕЛЮВАННЯ СТАЛОГО РОЗВИТКУ

ЗАХАРЧЕНКО Павло[1], НЕСТОРЕНКО Тетяна[1], КОЙНАШ Марина[2]
[1] Бердянський державний педагогічний університет
[2] Харківський національний економічний університет ім.С.Кузнеця

У статті досліджено особливості інноваційного розвитку курортно-рекреаційних міст та територій сфери в контексті трансформаційних процесів глобальної економіки та розбудови платформної економіки. Розглянуто сучасні тенденції інноваційного розвитку галузі, включаючи цифровізацію та впровадження передових технологій для підвищення якості рекреаційних та туристичних послуг. З урахуванням концепцій Й. Шумпетера, Г. Менша, А. Кляйнхета та інших дослідників проаналізовано вплив інновацій на економічні цикли, структурні зміни та конкурентоспроможність курортно-рекреаційних міст і територій. Особливу увагу приділено ролі інноваційних хвиль, що формують нові бізнес-моделі та змінюють економічний ландшафт галузі.

Запропоновано математичну модель вибору оптимальної інноваційної політики, яка базується на аналізі ефективності інвестицій у новітні рекреаційні технології. Використано узагальнене логістичне рівняння для моделювання динаміки технологічних змін, що дозволяє прогнозувати ефективність впровадження інновацій та їх вплив на стійкий розвиток територій. Визначено критерії оцінки інноваційних процесів, зокрема їх економічну доцільність, екологічну безпеку та соціальну значущість. Доведено необхідність інтеграції платформних рішень для підвищення адаптивності курортно-рекреаційної економіки.

Розглянуто можливості застосування цифрових екосистем та алгоритмічного управління для координації інноваційної діяльності та оптимального розподілу ресурсів. Визначено закономірності взаємодії інноваційних хвиль із економічними процесами, що забезпечують довгострокову стабільність розвитку курортно-рекреаційних міст та територій.

Запропонована модель інноваційного управління дозволяє оцінити ефективність різних стратегій розвитку, сприяє формуванню конкурентоспроможних бізнес-моделей і забезпечує стале зростання курортно-рекреаційного сектору.

Ключові слова: курортно-рекреаційні міста та території, сталий розвиток, платформна економіка, моделювання, інновації, інвестиції