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Imagining the New Development Concept of Lifelong Learning Toward Carbon Action Plan

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Abstract: In this research, we aim to increase the efficient and environmentally safe resource use and the development of sustainable practices based on lifelong learning. To achieve this, the aggregated modeling has been undertaken via the concept of life cycle thinking. The following models are introduced: (1) a model for the market of products with carbon risk toward application in the development of carbon action plan; (2) a model for the diffusion of innovative knowledge, with conditions for its lifelong learning implementation; (3) the adaptation mechanisms at competence acquisition and decision-making. The perfect market theory, as the basic approach, is used to investigate the problems of corporate social responsibility and standardization in the field of sustainability. Having in mind the practical implications, the economic and technological integrated factors of the techno-economic system have been introduced, and their relationship with the tasks of sustainability, taking into account carbon risk, is considered, based on the quantitative measures. The novelty of the research is provided by the aggregated analytical results in order to form tools for quantitative modeling on the sustainability issues of communities, organizations, and individuals.

Keywords: carbon action plan, innovative knowledge, life cycle thinking, life-long learning, sustainable development

1. Introduction

A number of papers have formulated key questions for scientific discussion about the patterns of sustainable development (SD), relating the basic innovations in accordance to a line of Technological Stages, which are going by the time-term period of about 40 – 60 years [1, 2]. The innovative techno-economic modeling [3–5] has been discussed. In particular, it has been noted that a major reform of the entire quality infrastructure is underway: changes in standardization legislation, roadmaps for improving certification and standardization, active creation and popularization of new quality tools, and the new development concept in education. This reform is a deeply natural process – standards are a tool for solving existing and future complex SD problems, based on fundamental laws, like the environmental Kuznets curve [6, 7]. The use of standards simplifies the transfer of knowledge and contributes to the further development of innovative solutions. Also, the life cycle thinking approach is used to analyze the value chain specified for transforming the human resources matched with the problems of sustainability [8]. The existing economic practice is mainly aimed at the analysis of the behavior of markets, and the tasks of market design and management, due to their extreme complexity, remain little explored [9]. Global economic crisis phenomena necessitate the theoretical and practical development of the concept "an economist as a market engineer." In particular, the tasks of sustainability and innovation management, taking into account carbon risks (CRs), are relevant now. The global carbon challenge needs to put energy conservation in the first place; implement a comprehensive conservation strategy; continue to reduce energy and resource consumption and carbon emissions per unit of output; improve input-output efficiency; advocate a simple, moderate, green, and low-carbon lifestyle; and form effective carbon emissions from the source and entrance control valve [10, 11]. Both the government and the market will work together to build a new development concept, strengthen technological and institutional innovation, and accelerate the green and low-carbon technological revolution [12]. Deepen reforms in energy and related fields, give play to the role of market mechanisms, and form effective incentive and restraint mechanisms [13].

In turn, it has been established that the economic policies would only be efficient if they are accompanied by adequate policies in the field of education [14]. In this sense, lifelong learning has become the umbrella for all prospective training programs and initiatives for sustainability competence, the new one among which is, of course, the global carbon challenge [15]. So, in practice, there is a need to study how lifelong learning could support sustainability. A bulk of publications on environmental, social, and economic themes has been turned into consideration of which measures can be best used for sustainability competencies practicing [16–18]. The solution of the abovementioned tasks involves an analytical consideration of the market equilibrium, under the criteria of Economic Efficiency, Environmental Safety, and Social Well-being, the coordinated implementation of which is the essence of sustainability and innovation management [11]. So, our imaginations on the integration of modern environmental and socially responsible technologies and competitive market mechanisms undertake constructive tools for improving innovative research for the new developments in lifelong learning toward carbon action plan.

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2. Materials and methods

To solve the problems mentioned above in terms of promoting SD, we use the well-known concept of "Life Cycle Thinking" [19]. This approach opens up wide opportunities for the development of constructive tools for the practical implementation of the principles of SD [20, 21]. Also, we apply the tools of the multi-criteria technique, which has successfully proven itself in solving complex problems in the study of the product life cycle. In the context of the undertaken research, we consider the model of establishing equilibrium in the system of markets of the product life cycle. At the same time, each producer and consumer acts in this way to maximize their profit. The equilibrium in the market is established by maximizing production and consumption preferences (*QS, QD*) and minimizing the corresponding damages (*GS, GD*):

$$Max\, QS^i \,\&\, Max\, QD^j \,\&\, Min\, GS^i \,\&\, Min\, GD^j \tag{1}$$

Here, the private agents in the life cycle chain have cost (*S*) and utility (*D*) functions that ones at our approach are proposed in accordance with the principle of resource utility. The core of the appropriate models is the quality functions ($K_{S,D}$) of the resource vector under the universal Weber–Fechner law at the exchange economy:

$$\begin{gathered} QS(u,W) = W - S(u), \\ S(u) = KS(R_S) - KS(R_S - u) + S(0), \\ QD(v,W) = D(v) - W, \\ D(v) = KD(R_D + v) - KD(R_D) \end{gathered} \tag{2}$$

Here, W is the value of the transaction; $R_{S,D}$ is the initial resource quantities; $K_{S,D}$ is the quality of resources, with the condition $\partial K_{S,D} > 0$; and $G_{S,D}$ will be the risk functions, produced by production and consumption activities. The material flow at every market of the product life cycle is designed in balance of demand and supply driving forces [22]:

$$\begin{gathered} Max\, Q(v,u) \\ Q(v,u) = \sum_J DR^j(v^j) - \sum_I SR^i(v^j)], \\ While: \sum_J v^j = \sum_I u^i, \ and \\ DR^j = D^j - GD^j, \ SR^i = S^i + GS^i - S^i(0) \end{gathered} \tag{3}$$

And the key position at the noted optimization problem is the positivity of the function *Q*(*v*,*u*) that one is our first result under consideration below.

In order to study the product markets with CR, a value-added model (AV) is being developed, which forms the basis for determining the CR in the market of this product. Indeed, according to the task No. 9.4 "Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development: by 2030, modernize infrastructure and re-equip industrial enterprises, making them sustainable by increasing the efficiency of resource use and wider use of clean and environmentally friendly technologies and industrial processes, with the participation of all countries in accordance with their individual capabilities," the indicator No. 9.4.1 "CO_2 emissions on a unit of added value" is applied. According to the indicator No. 9.4.1., the model for CR has the form:

$$CR = \sum_I \gamma^i * AV^i \tag{4}$$

Here, the introduced parameter "γ^{i}" is argued by the innovative knowledge transformation and is responsible for the technological efficiency of resource consumption by i-production.

To investigate the noted transformation, there is a need to provide the appropriate knowledge model. To clear the real value for the noted parameter, we have undertaken the following approach. In relation to the task of collective adaptation of supply and demand in the product market, taking into account the criteria of sustainability, we consider a model in the form of a theoretical construct "decision maker, DM." The DM uses the available information ("input") to form solutions ("output"). A constructive mathematical model of decision-making processes carried out by the DM is a scheme of multi-criteria selection from a set of acceptable alternatives.

The formalization of the choice problem is as follows: from a set of objects (in particular, "alternatives for decision-making," *H*), it is required to choose a subset with certain rational properties. If there is a choice function "*F*," then the result of the decision is written as: $Y = F(X), Y \subset X \subset H$.

When the Pareto mechanism is used as a selection tool, such a choice function quite objectively formalizes the concept of "knowledge." Indeed, the following rationality conditions corresponding to the concept of "knowledge" are fulfilled [23–25]:

1) If an alternative is selected from a certain set, then it will be selected from any subset containing it;
2) If an alternative is selected in each of the given set of sets, then it will be selected from their union as well;
3) If all alternatives selected from some set are contained in its subset, then they, and only they, will be selected from this subset;
4) If an alternative is selected from a certain set, then there is no more preferred alternative in a partial order.

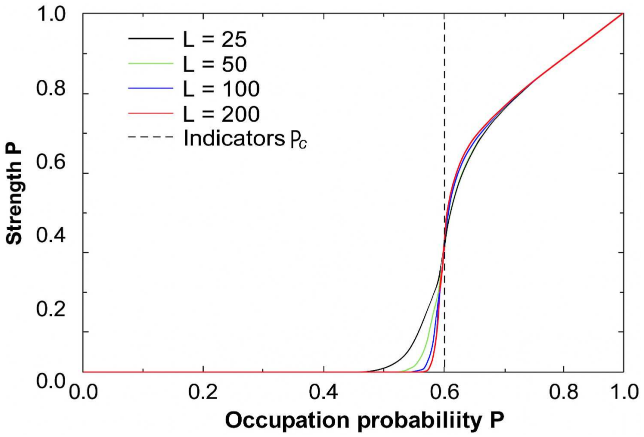
Thus, the correct embodiment of such "natural" properties of rational knowledge includes the inheritance of the results of previous decisions, consistency of general and particular results, and independence of the new choice from already rejected alternatives. So, we have:

1) Inheritance (*I*): $Y \subset X \rightarrow F(Y) \supset F(X) \cap Y$
2) Consent (*C*): $X = YUZ \rightarrow F(Y) \cap F(Z) \subset F(X)$
3) Rejection (*R*): $F(X) \subset Y \subset X \rightarrow F(Y) = F(X)$

At last, we'll use the threshold phenomenon at the two-dimensional lattice [26]. For example, at each market from the product life cycle, the aggregates "demand" $\{J\}$ and "supply" $\{I\}$ form a two-dimensional lattice, each node of which corresponds to the pair "j-demand, i-supply" ("*i*" is an element from the set *I*, "*j*" is an element from the set *J*). Such a pair, depending on the professional quality of market participants (here is the probability of meeting "the established requirements of SD"), may meet the requirements of sustainability (with probability "*p*") or not be SD (with probability "1 — *p*"). So, let the probability of fulfilling the property "σ" for node (*i, j*) be the value "*p*": $P\{\sigma(i, j)\} = p$. It is known, if $p > p_c$ ($\approx$ 0.59), then there is a connected set of nodes percolating the opposite sides of the two-dimensional lattice "percolating cluster, Σ." There is the threshold dependence of the probability site belongs to Σ along the lattice dimension, *L* (Figure 1).

The introduced version is called further as "market threshold." However, there is another example, which is called "competence threshold." The last one is related to the two-dimensional lattice of the selection functions. Here, the desired property of the pair (F_i, F_j) is that $F_i \cap F_j$ is the selection function under the conditions *I* & *C* & *R*.

Figure 1
The threshold dependence of the probability site belongs to percolating cluster



3. Results

Here, we'll consider the example of "market threshold," where the desired SD property $\sigma(i, j)$ contains the condition: $d^j = \partial DR^j|_{v=0} > \partial SR^i|_{u=0} = s^i$. Then the site (i, j), in view of, for example, $\partial^2 DR^j < 0$ and $\partial^2 SR^i > 0$, has the local stable equilibrium. In turn, if the noted condition holds for all pairs (i, j), then the market will have an equilibrium. Indeed, let $d^j > s^i$ for all sites (i, j), then we have step by step:

$$\begin{aligned} v^j * d^j &> s^i * v^j \\ \sum_J v^j * d^j &> s^i * \sum_J v^j \\ u^i * \sum_J v^j * d^j &> u^i * s^i * \sum_J v^j \\ \sum_J v^j * \sum_J v^j * d^j &> \sum_J v^j * s^i * \sum_J v^j \end{aligned} \tag{5}$$

And, in turn we have:

$$\sum_J v^j * d^j > \sum_I u^i * s^i, \tag{6}$$

because $\sum_I u^i = \sum_J v^j$

Due to the last one, the maximization problem for $Q(v,u)$ has a solution.

The chain represented above is true for the case: $dim(d) = dim(s) = 1$. In turn, for $dim(d) = dim(s) = n > 1$ by the induction process for "n," the undertaken optimization problem has a solution for the vector supply and demand too. In addition, the noted equilibrium will be locally stable due to the monotone decrease of the appropriate Lyapunov function.

Our main result provides the value of CR as a function of the equilibrium volume of the product (Z) in the form of the characteristic U-inverse relationship (analogous to the environmental Kuznets curve). This result allows us to propose an iterative procedure for minimizing CR while maintaining monotonous growth of income (GP) along the K-cycle.

According to the threshold concept of the competitive market established above (market threshold), the existence of equilibrium at the elementary cells (node (i, j)), when their critical density is reached, is sufficient for the equilibrium at the corresponding part of the market. Therefore, omitting the indexes "*i, j,*" we can limit ourselves to the basic model of a single node. So, the corresponding multi-criteria problem in such a situation has the form: QS → Max, CR → Min, QD → Max (QS – producer's profit, QD – consumer's profit).

Then the supply is uniquely given by its production function: $U = U_0 K^{\alpha} A^{\beta}$ (A – "labor", K – "capital", α, β – inverse elasticity), which gives an expression for income ($GP = \pi * U$) according to the following relation:

$$\begin{aligned} GP &= (a * K + A + M) * (1 + b) + P * (1 + c) + d * AV \\ AV &= (a * K + A + M) * (1 + b) + P - M \end{aligned} \tag{7}$$

Here, AV is the value added, "a" is the tariff for depreciation, "b" is the tariff for overhead costs, "c" is the profit tax tariff, "d" is the value-added tax tariff, "M" is the material consumption by the product, and "P" is the profit.

The classical utility function of demand in volume "V" (as part of the consumer's profit QD) has the form: $D = D_o * LN(1 + V/V_0)$, and D_o is the available financial limit and V_0 is the available stock of the product. And, the equilibrium value of the product (Z) is determined from the condition:

$$\begin{aligned} &\partial A(Z) * (1 + b) * (1 + \Delta) + \\ &\partial M(Z) * (1 + b * (1 + \Delta)) = \partial D(Z) \end{aligned} \tag{8}$$

Here, the effective tariff of the value-added tax $\Delta = d + \gamma * g/(1 - \gamma * g/(1 + c + d))$, g is a parameter of the multi-criteria optimization problem, and γ is a technological parameter determined by the efficiency of resource consumption.

The presented CR model has the following boundary properties:

$$\partial_z CR(Z = 0) > 0, \; \partial_z CR(Z = Zmax) < 0 \tag{9}$$

Due to these conditions, there is a solution (Z_e) to the problem: $Max_{(Z)} CR(Z)$. Next, using the parameters $\Omega = \{D_o, V_0, \alpha, \beta, U_0, K, \gamma, g, a, b, c, d\}$, we can select Ω_1 from the condition $Z(\Omega_1) > Z_e$. Then, by virtue of the boundary properties, we have: $CR(Z_e) > CR(Z(\Omega_1))$ and $GP(Z(\Omega_1)) > GP(Z_e)$. Then the procedure is repeated for the new parameters Ω_2 from the condition: $Z(\Omega_2) > Z(\Omega_1)$, etc. As a result, we get the sequence:

$$\begin{aligned} &\ldots CR(Z(\Omega_k)) > CR(Z(\Omega_{k+1}))\ldots \\ &\ldots GP(Z(\Omega_k)) < GP(Z(\Omega_{k+1}))\ldots \end{aligned} \tag{10}$$

The represented sequences, due to the features of the CR and the income at the market, are similar to those of every node, solving the problem of managing the market with CR within the K-cycle.

Combining the represented results, we can imagine the following lifelong learning program toward carbon action plan. Let the current and desired CRs be CR_c and CR_d, respectively, and the time-term horizon $K = t_d - t_c$: $CR_{c,d} \to Z_{c,d} \to \gamma_{c,d}$, where we have the appropriate current and desired resources' efficiency due to the technological parameter $\gamma_c > \gamma_d$. And, having $\partial_\gamma Z < 0$, the appropriate lifelong learning plan for time-term horizon K could be the following $\gamma = (k)$:

$$\begin{aligned} &\gamma(k + 1) = \gamma(k) - \Delta y(k), \; 1 \le k \le k - 1, \\ &\gamma(I) - \gamma_c, \; \sum \Delta y(k) = \gamma_c - \gamma_d \end{aligned} \tag{11}$$

Some additional condition could be applied like this $\Delta\gamma(k)/\gamma(k) = \delta$, it is constant that one provides the available equal intensity of innovation promotion by time.

These conditions represent a formalized position on the basic role of the concept of "individual preferences" in human activity in terms of decision-making, which is the core activity of the DM. If the selection functions $\{F_n\}$ in the amount of "N" are used for the operation of the DM at the input and the selection functions $\{G_m\}$ in the amount of "M" at the output, then on the basis of such tools, the model characterizing the operation of the DM gets the form:

$$G_m(X) = \sum_n A_{mn} F_n(X) \tag{12}$$

Here, $X \subset H$ is the set presented for selection, $A_{mn} \subset H$ are constraints in the selection problem with the condition of completeness and independence of the events A_{ik} and A_{ij}, and H is the basic set of alternatives to the selection problem, on the set of subsets of which the "multiplication, ∩" and "addition, U" operate, specifying the structure of the DM model.

The presented DM model is determined up to free events, and their number is $E(e) = C_R^{M+1} - N$, where $R = N + M$ is the number of knowledge realization centers. The value "$E(e)$" represents the total number of free events that determine the choice functions in the number R, associated with the "M" operating conditions of the DM. The efficiency of the DM activity, as the resulting share of decision-making centers, is further characterized by the indicator $e = M/M_{max}$ $(0 \le M \le M_{max} = R-1$, "efficiency of the DM, e", $0 \le e \le 1)$. Obviously, with the increase in the value of "$E(e)$," the possibilities of adaptation in the activities of the DM also grow. Taking into account the nature of the change in the value "$E(e)$" with an increase in the number of M-functions, in particular for the case $R \gg 1$, we obtain a tool for optimizing decision-making processes:

$$\uparrow e \rightarrow \uparrow E,\ at\ 0 \le e \le [R/2];\ \uparrow e \rightarrow \downarrow E,\ at\ R-1 \ge e > [R/2] \tag{13}$$

Based on the introduced DM model, it is possible to formalize the relationship between the objective quantitative characteristics of the established requirements of SD (p) and the professional competence of the DM (sustainability competence probability, q). Here, we use the assessment of the level of competence as "The probability of performing a work activity in accordance with the certain sustainability requirements in a real working environment." So, the noted relation has the form $p = WFL(q)$, which is a kind of the fundamental Weber–Fechner law for the "stimulus-response" ratio. This dependence is due to the possibility of adapting the components of the input-output system of the DM, which is determined by the level of its complexity $E(e)$. Then, considering the dependence $E(e)$ as an un-normalized probability density of the DM efficiency indicator, for the desired dependence $WFL(q)$, and the boundary conditions $\{WFL(0) = 0,\ WFL(1) = 1,\ WFL'(0) = \varepsilon,\ WFL'(1) = 0\}$, we obtain the approximation of $WFL(q)$ at $0(R \gg 1) \le \varepsilon \le 1(R = 5)$, refer the work by Voronov [22]:

$$p = WFL(q) = (\varepsilon - 2) q^3 + (3 - 2\varepsilon) q^2 + \varepsilon q \tag{14}$$

The next step in our discussion is based on the version "competence threshold." So, if $F_i \cap F_j$ is the selection function under the conditions $I\&C\&R$ for all (i, j), then the same we have for the set $\{F_i\}$ and for all pairs $F_n \cap G_m$ at two-dimensional lattice N x M. So, the last one, due to the "natural" properties of the rational knowledge, is treated as the desired competence at the decision-making process because G_m is $I\&C\&R$-selection function. Also, a number of dynamic regularities of large K-cycles are known. In particular, it is believed that the characteristic period of this phenomenon is about 50 years. The significant factor in the reduction of this period (e.g., acceleration of the pace of creation and implementation of innovative knowledge) is determined by the intensity of the processes of diffusion of knowledge carried out by the collective DM. Obviously, if the structure and parameters of the model of this phenomenon correspond to reality, then the estimates of characteristic quantities will correspond to the observed data. To the opposite, apparently, it will be true only in a particular or narrow aspect. Based on the above proposed competence model, and the expression for the dependence $p = WFL(q)$, it is possible to solve the problem of estimating the scale of K-cycle ($t^*(\delta,\ p_c)$ – the time term for which collective competence reaches the qualitative update) from the condition:

$$p_c = \left(\frac{1}{T}\right) \sum_{n=t-T+1}^{n=t} WFL(q(n)) \tag{15}$$

Here, T is the characteristic period of professional activity of the collective DM (e.g., T = 65–25 = 40 years), and $q(n)$ is determined by the iterations:

$$\begin{gathered} q(n+1) = q(n) + \Delta q(n),\ q(0) = 0 \\ \Delta q(n) = \delta * (1 - q(n)) \\ or,\ q(n) = 1 - X(n) \\ X(n+1) = X(n) - \Delta X(n),\ X(0) = 1 \\ \Delta X(n)/X(n) = \delta \end{gathered} \tag{16}$$

The undertaken calculations provide the following examples:

$$\begin{gathered} t*(\delta = 0,03,\ p_c) = 49 \\ t*(\delta = 0,0236,\ p_c) = 56 \end{gathered} \tag{17}$$

Now, we can test our models, for example, for the parameters from building and construction practice (production of some construction material): $V_o = 5.0$, $D_o = 162.5*10^3$, $\alpha = 0.356$, $\beta = 0.644$, $U_o = 177$, $a = 0$, $b = 0.3$, $c = 0.2$, $d = 0.15$, $1.34 > \gamma > 0$ (see Figures 2 and 3), and for $\gamma_c = 1.28$, $\gamma_d = 1.00$, we have $K_1 \approx 10$ years (with

Figure 2
Carbon risk as function of product volume (Z) environmental Kuznets curve of the market with carbon risk

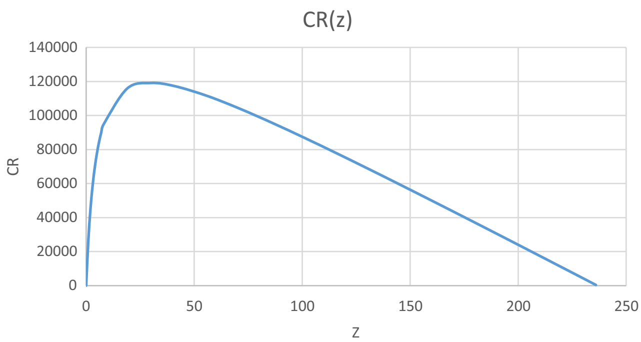
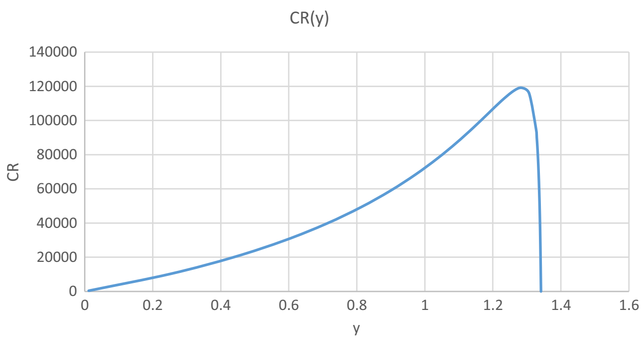


Figure 3
Carbon risk as function of technological parameter (y)



$\delta_1 = 0.0236$) and $K_2 \approx 8$ years (with $\delta_2 = 0.03$). By this example, one can find within the K-cycle the standard rate $K \sim 1/\delta$ for the lifelong learning time term.

The numerical order and regularity of the obtained result, along with the objectivity of the constructed DM models and the threshold phenomenon of sustainability, can serve as an important additional argument for the applied consistency of the considered innovative tools.

4. Conclusions

Our results start with the threshold phenomenon at the market, modeled by its cost and utility functions. So, the sustainability of the market (here, it is the local stable equilibrium existence in the presence of the damage factors) is provided by the sustainability at every pair of supply and demand. Based on the noted possibility, we've proposed the equation for the equilibrium of the appropriate multi-criteria problem for the product market with CR. The represented model provides the value of CR as a function of the equilibrium volume of the product in the form of the characteristic U-inverse relationship (analogous to the environmental Kuznets curve). Here, the CR is measured with the proportion "CO_2 emissions on a unit of added value." The last one provides the iterations to improve production technology, based on innovative knowledge implementation through lifelong learning. This procedure presents the imagination for the carbon action plan. The important parameter of such a procedure is the rate of CR decrease. We've tested an option for choosing this parameter based on the formation patterns (like some kind of Weber–Fechner law) for large cycles of innovations.

In this regard, the introduced model parameters (the level of core competence, the scale of inertia of adaptation of management competencies, parameters of communication processes in a techno-economic cluster, etc.) determine important quantitative patterns of resource transformation chains. Thus, in the conditions of decision-making "by the majority," it is necessary to prevail the share of management, which ensures the level of average profile competence in the markets of the product life cycle above a certain critical value.

The estimates obtained, which, according to the presented results, give the bounds of the characteristic values, correspond well to the known theoretical and experimental facts about the dynamics of K-cycles of the economic conjuncture of "about half a century" duration. Due to the revealed properties of such dynamics, the acceleration of the formation of the technological structure could be facilitated. For example, it is provided by the unification (including standardization of quality) of the processes of training specialists. Continuous updating of qualifications throughout the entire period of work activity is improved due to the distributed educational networks, as well as increased communicative intensity in the corresponding techno-economic cluster. It is also significant that at the same time, the elasticity of the period of establishing SD in the conditions of an expected increase in the average duration of labor activity turns out to be less than one.

In general, the introduced analytical models of innovative techno-economic development correspond to the known qualitative patterns of these processes and allow us to obtain new, reliable quantitative results in the tasks of personnel adaptation for successful innovative technologies. The represented models of sustainable resource transformation provide a sound practical toolkit for the investigation of new qualitative and quantitative patterns in solving complex socio-economic problems, corresponding to the dynamics of K-cycles and long-term requirements for standardization at the SD paradigm. At the same time, modeling in the context of the product life cycle turns into a conceptual basis for the rational analysis, and these tools have appeared and are being improved that have significant prospects for the development of analytical methods in sustainability engineering.

For example, among solutions for some prospective tasks, based on our approach, the task of tariff management could be discussed. So, in the tariff regulation of economic activities, along with tariffs for assets amortization, overhead costs, and profit tax, value-added tax is also available for management. The analysis of the multi-criteria model used above as the basis for CR modeling makes it possible to introduce an equivalent tariff for the value-added tax, taking into account the component of the corresponding damage term. Then the growth of this tariff increases the weight of the problem of reducing CR, which serves as an additional tool for tariff management of a product market with CR.

The other task of managing the regional economy could also be tested. In a number of works on econometrics, models of aggregated production and consumption for the region as a whole have been developed. As can be seen, such a model corresponds by the form to our consideration of a fixed node of the market network. So, the noted fact allows the application of the introduced iterative risk and income management procedure in the case of individual regions.

Of course, the introduced applications of the threshold phenomenon are not restricted to the tested tasks. The other prospective area for the noted design is connected to the stock exchange and rating agencies practicing.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by the author.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

The data that support the findings of this study are openly available at https://rosstat.gov.ru/bgd/regl/b14_46/Main.htm.

Author Contribution Statement

Alexander Voronov: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Visualization, Supervision, Project administration.

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