DOI: 10.55643/fcaptp.5.64.2025.4852

MODELING OF FINANCIAL RESULTS OF ENTERPRISE ACTIVITIES IN THE PARADIGM OF SOCIAL BUSINESS RESPONSIBILITY

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Received: 01/06/2025
Accepted: 01/10/2025
Published: 31/10/2025

ABSTRACT

The article investigates and models the process of forming financial results of an enterprise operating in technogenic conditions on the basis of the social responsibility of business. It is proposed to consider technogenic conditions that are formed directly by the enterprise itself as self-pollution. The formed economic and mathematical model allowed to analyze the financial results of an enterprise operating in technogenic conditions. The optimal value of technogenic self-pollution was determined. It is shown that when the values of technogenic pollution are less than the optimal value, the profit of the enterprise increases. The application of methods of similarity theory made it possible to present the economic and mathematical model of the enterprise's profit in a dimensionless form, replacing individual parameters with analytical complexes that are recorded in the form of products. This allowed for a reduction in the volume of necessary calculations during research. The importance of the synergy of environmental standards and the financial component of the enterprise, in combination with the component of social responsibility of business, is proven.

The methodology for the formation of economic and mathematical modeling of the financial component of enterprises operating in technogenic conditions has been developed. The possibility of using differential equations at a qualitative level is shown. This made it possible to determine the feasibility of using "soft" economic and mathematical models. It has been proven that there is an optimal value of the enterprise's income with the corresponding value of man-made pollution, which is characterized by structural stability.

Economic and mathematical modeling of the financial indicators of the enterprise's activity in relation to technogenic self-pollution has made it possible to determine, using a dimensionless approach, the optimal conditions of the cost-target components. The conducted research provides enterprises with a tool for forming a financial strategy for their activities in technogenic conditions on the basis of social responsibility.

Keywords: enterprise, soft model, technogenic conditions, social responsibility, financial reporting, profit, income

JEL Classification: C19

INTRODUCTION

The modern dynamic development of the economy based on the achievements of scientific and technological progress has a negative impact on the external environment. The state of the environment has deteriorated, and natural resources are being depleted. Society, having reached an extremely high level of knowledge and development, has created a real threat to its existence (Chugai, Safranov, 2020).

Current changes in the state's social sector require corresponding changes in business processes. The development of industry and the introduction of new technologies have led to corresponding changes in the economy and ecology. It should be noted that such changes are not always positive. Therefore, the social responsibility of business is becoming relevant (João, P.R. & Gramkow, C., 2020). A new direction of requirements is being formed aimed at including in its activities processes that have a positive impact on the economy and ecology. The synergy of these components lies at the heart of the social responsibility of business. It is the social and environmental aspects that become the cornerstone in the formation of the financial results of the enterprise. Of course, environmental problems are created by technogenic conditions in general and pollution of the external environment, which is formed directly by the enterprise itself.

Gradual neglect of critical risks leads to irreversible problems in the field of enterprise activity. In Ukraine, in modern conditions, the operation of enterprises is based on obtaining maximum profit, while neglecting the optimization of costs for environmental protection. This leads to the creation of technogenic conditions in which not only the enterprise operates, but also the surrounding life systems. Attempts to save money are the main "driver" of disasters and critical risks. Technogenic conditions are also promoted by corrupt actions, when, in order to obtain excess profits, the relevant norms are ignored. Of course, any system, including the enterprise, has limits to its functioning. Therefore, a timely level of funding for the environmental component of the enterprise will allow avoiding critical risks. There are relevant requirements that regulate the restrictions on the creation of a technogenic environment. The validity of such regulated restrictions is dictated by common sense. After all, the technogenic environment negatively affects the surrounding nature and the health of residents. In modern conditions of imperfect technologies, it is impossible to completely avoid technogenic conditions. Therefore, it is logical to solve the problem of possibly limiting the relevant man-made environment in general and pollution in particular.

In this sense, the need to take into account the relevant norms regarding the technogenic conditions of the enterprise's functioning are highlighted. The activities of any enterprise involve making profits; therefore, there is a need to determine the value of technogenic pollution at which the enterprise's profits will be maximized. If such an optimal value of technogenic pollution turns out to be less than the ecological limit value, then it makes sense to adhere to this optimal value. Economic and mathematical modeling of financial indicators regarding the effect of the relationship with the technogenic environment formed the basis for clarifying the conditions for the existence of the optimal value of technogenic pollution. The formation of a "soft" mathematical model of the enterprise's financial indicators made it possible to reveal their features under technogenic pollution. The analysis of the model proved the presence of a stable structure of the corresponding indicators. In turn, the application of similarity theory methods made it possible to present an economic and mathematical model of the enterprise's financial activities in a dimensionless form. Such reproduction is based on replacing the corresponding parameters with analytical complexes, which are recorded in the form of products. This allowed, in addition, to reduce the volume of necessary calculations during research.

Modern directions of financial activity of the enterprise are devoted to substantiating the most effective ways of solving problems faced by business entities. One of the directions of solving modern challenges is ensuring the financial activity of the enterprise in technogenic conditions and its adaptation to the external environment. Adaptation of the enterprise to rapid changes in the external environment is the main factor that contributes to the financial capacity of the enterprise. The synergy of environmental standards, the financial component of the enterprise, as well as the social component, is important in the adaptation process. The use of economic and mathematical modeling allows for determining the financial capacity of the enterprise in order to ensure its strategic development. It is clear that compliance with restrictive norms requires appropriate financial planning, which should ensure the implementation of the financial strategy of the enterprise in technogenic conditions. That is, the chain of components economy-ecology-social responsibility forms the basis for the formation of requirements for the financial results of the enterprise.

It is emphasized that the formed economic and mathematical model of the financial component in technogenic conditions allows, in an analytical and formal representation, using appropriate calculations, to substantiate and provide recommendations on the optimal value of technogenic pollution of the enterprise. At the same time, optimal indicators of the corresponding financial parameters of the model are achieved. The importance of the development and correct use and interpretation of economic and mathematical models is difficult to overestimate.

The modern development of progressive technologies should be aimed at improving the well-being of people. However, the same progress has its negative sides, such as environmental pollution. Scientific and technical achievements of modernity have certain contradictions. As a result of the activities of industrial enterprises, the use of not only modern equipment and technologies, but also outdated equipment, the environment is polluted with technogenic waste. The negative impact of technogenic pollution concerns the life support system of humanity. Therefore, there is a need to determine directions for overcoming the above-mentioned problems. One of the possible directions is aimed at substantiating and applying economic and mathematical methods and models. This approach will allow determining the necessary cost-effective means that will be aimed at reducing the negative impact of technogenic pollution from the operation of enterprises.

LITERATURE REVIEW

Today, in the context of environmental research, research on the impact of the technogenic environment on the activities of enterprises has received further development in the center of scientific studies. In particular, a team of scientists, Khorol's'kyj, V.P., Riabykina, K.H., Khorol's'kyj, K.D. is investigating innovation processes for enterprises in the region with technogenic territories. The theoretical, methodological, and practical components of the innovation process of the region have been analyzed in detail, taking into account the specific features of its territory. The scientists used the developed models to determine the economic state of technogenic territories in general and enterprises separately (Khorol's'kyj, et al., 2018; Khorol's'kyj, et al., 2019). Numerous scientific studies are devoted to the application of modeling methodology to the activities of enterprises in technogenic conditions. It should be noted that these studies combine social and economic processes with possible crises and technogenic situations in which the enterprise operates. The scientific achievements of Raevneva, O. V., and Su, R. attract attention. Researchers have developed a simulation model of "…economic behavior of an enterprise taking into account the sensitivity of its type of economic activity to crisis processes…". The authors applied systematicity in their research. The conducted comprehensive analysis of the enterprise's activities became the basis for building a simulation model of its functioning. The scientists took into account the sensitivity of the economic component of the enterprise to possible crisis situations (Raievnieva, Su, 2024).

Currently, research that takes into account the crisis periods of the state is relevant for the scientific community. Scientists Trisnyuk V., Dzyuba V., and Tymchuk V. paid attention to the study of "…modeling the elimination of the consequences of military actions and man-made disasters on the territory of Ukraine…". The authors used a program-target approach to solve the problem. This approach, combined with Pareto functions, allowed finding the optimal plan for using "…the man-made security system at the stage of eliminating the consequences of military actions and man-made disasters…" (Trysniuk, Dziuba, Tymchuk, 2024).

Scientists Nevol'nichenko, A. I., Chumachenko, S. M., Mykhajlova, A. V., Pyrikov, O. V. & Murasov, R. K.proposed to apply the system dynamics method in the process of assessing the technogenic impact on the environment. The authors focus on "…the probability of occurrence of emergencies of a technogenic nature at critical infrastructure facilities…". The proposed approach allowed laying the foundation for the formation of a mathematical model "…threats of occurrence of emergencies at critical infrastructure facilities…" (Nevol'nichenko, et al., 2022).

An in-depth study can be considered the work of scientists Popov O. O., Kovach V. O. Applying situational analysis, mathematical models were formed that take into account technogenic situations when making management decisions. The features of the proposed models are the formation of stages, taking into account the relevant parameters regarding influential factors. Author Kravets D. D. proposes the use of simulation modeling to calculate indicators of financial assets. The proposed models take into account the main factors of influence on the activities of the enterprise, namely, financial assets (Kravets', 2023).

The use of a situational approach in technogenic conditions when adopting management levels was proposed by Popov O. O. & Kovach V. O. The authors identified the most influential factors and investigated their effect on technogenic conditions. The researchers formed an appropriate mathematical model and proved the feasibility of its application in technogenic conditions (Popov, Kovach, 2018).

The development of technocracy in society has led to negative consequences for the use of natural resources. Accordingly, industrial enterprises have losses caused by technogenic conditions. The scientist Zubayr Ahmad investigated the essence and content of the concept of technogenicity. The influence of this concept on the issue of solving problems in the legal sphere (Zubajr, Akhmad, 2023).

The essence of the concept of security is devoted to the studies of Polukrovka Yu. O., Polukrovka O. I., Prykhovnil N. A., Demchuk G. V., Mitka L. O., Kachynskoy N. F. The authors emphasize: "… the special importance of ensuring technogenic safety due to constantly growing threats…". A sharp approach is proposed to ensure effective management in technogenic conditions (Polukarov et al., 2020).

The current situation in the state requires an immediate solution to the problem of accounting for technogenic waste. Scientist Plokhyi V. M. devoted his research to legal issues regarding "… the use of technogenic (industrial) waste, determining the regulatory bases for classifying technogenic waste according to the degree of their environmental hazard…". The legal uncertainty of this current problem gives grounds for the creation of appropriate registers. This will provide grounds for the development of strategies for the development of the state (Plokhyj, 2020).

The studies of the authors Pigulevsky P. G., Podrezenko I. M., Anisimova L. B., Tyapkin O. K. are sound. The research concerns a specific region, namely the territory of the south of Kryvyi Rih. Mining enterprises of this region pose a threat

DOI: 10.55643/fcaptp.5.64.2025.4852

to its environment. The mining industry has a negative impact on the environment of the Kryvyi Rih region. The authors emphasize the need to develop a methodology for determining the technogenicity of the relevant territory (Pihulevs'kyj, et al., 2020).

Scientist Kopteva G. M. investigated the processes of economic security, which are directly related to business processes at the enterprise. Accordingly, economic security must also take into account the risk of technogenic situations (Koptieva, 2020). The author, Polyak K. Yu., investigated the economic system, its components, and the corresponding impact on each emergency situation. The researcher "… established that each aspect of the consequences of emergencies affects the system of economic activity management…" (Poliak, 2017).

It is logical that the activities of an enterprise in technogenic conditions are related to management. Therefore, scientific publications on the issues of management attract attention. To a greater extent, they are aimed at studying business processes. Thus, Tur O. V., Matusevych A. S. worked out the issues of building business process models and their application in their evaluation (Tur, Matusevych, 2018).

The corresponding scientific research is reflected in the publications of Konenko V. V. and Kopteva G. M. The scientists proposed their vision of the methodology of designing business processes and their evaluation from the point of view of economic security (Konenko, 2020; Koptieva, 2020).

Modern digitalization of the economy provides for new approaches to modeling business processes. The authors Shmatkovska T. O., Dzyamulych M. I., Stashchuk O. V. outlined in detail "…systematization of the features of the process of modeling business processes with the use of cognitive technologies and artificial intelligence…". Scientists have identified the directions of development of business modeling of economic systems (Shmatkovs'ka, Dziamulych, Staschuk, 2021).

Undoubtedly, the activity of an enterprise in technogenic conditions requires innovative management solutions. Tregubov S. investigated the processes of innovation management in modern changing conditions of the economic environment. The researcher identified areas of possible improvement in the innovation structure of the economic system (Trehubov, 2023).

The author Kvitka T.V. proposed a model of the profit and income of an enterprise in conditions of technogenic pollution. The formation of a soft model of the profit of an enterprise is proposed. The activities of enterprises in the Dnipropetrovsk region (Kvitka, 2020). The authors Shishkina O. V., Baranets A. A. have outlined in detail the definitions of the financial activity of an enterprise. Scientists indicate that one of the components is "the search for reserves to minimize costs and increase income..." (Shyshkina, Baranets', 2017).

Scientific works of scientists systematically and comprehensively characterize the activities of enterprises. At the same time, the issue of adapting financial activity to the environment is not sufficiently covered in the scientific field. This necessitates the further study and improvement of methods of economic and mathematical modeling for the study and analysis of the financial activity of an enterprise in technogenic conditions.

AIMS AND OBJECTIVES

The goal is to investigate and model the process of forming financial results of an enterprise operating in technogenic conditions on the principles of social responsibility of business.

The research objectives are:

- to investigate the features of the enterprise's activities in technogenic conditions;
- to form an economic and mathematical model of the financial results of an enterprise operating in technogenic conditions;
- to analyze the component of social responsibility of business in the context of the financial results of an enterprise in technogenic conditions.

METHODS

The research was based on the application of the theory of similarity and the theory of differential equations in the formation of a mathematical model. A systematic approach to the critical analysis of methodological approaches to the activities of enterprises in conditions of technogenic pollution. To determine the cost-target characteristics of the activities of enterprises, methods of comparative and statistical analysis were used. The method of deduction is used in the article for the formation of recommendations and conclusions.

It is well known that in its simplest form, profit (P) is the difference between income (I) and expenses (E) incurred to obtain it. Moreover, all of the above components are influenced by many factors.

The conclusion obtained regarding the negative impact of technogenic pollution on the enterprise's income is logical. Based on the assumption of a directly proportional dependence of the enterprise's income on self-pollution, a "rigid" model was formed, which is analytically defined as the Cauchy problem: (Kvitka, 2020; Martynenko, Mishchenko, 2019):

$$\begin{cases} \frac{dI}{d\lambda} + \alpha \cdot I = 0 \\ I(\lambda = 0) = I_0 \end{cases} \quad (1)$$

where $\lambda -$ intensity of technogenic self-pollution, 1/year, $\alpha -$parameter, year, $I_0 -$income in the absence of technogenic self-pollution, conventional units.

The parameter λ determines the level of technogenic self-pollution. Tracking the change in this parameter allows you to determine the corresponding level of technogenic self-pollution. In addition, the possibility of using modern information technologies is provided. Analysis of the analytical ratio (1) indicates a directly proportional relationship between the parameter and technogenic self-pollution. The content of the parameter λ itself is outlined by the features of technogenic conditions.

The property inherent in the "rigid" model (1) is meaningfully represented by the parameter α, which has a constant value with respect to the value λ. The qualitative analysis conducted on the solution of the Cauchy problem (1) gives grounds to note that the values λ must meet the requirements for distinct values of the parameter α. That is, there is a corresponding interdependence between the value λ and the parameter α. In this case, it is logical to state the functional dependence of the parameter α as a function of the variable λ. Thus, the analytical representation of the Cauchy problem (1) takes the following form:

$$\frac{dI}{d\lambda} + \alpha(\lambda) \cdot I = 0$$
$$I(\lambda = 0) = I_0 \quad (2)$$

where $\alpha = \alpha(\lambda) -$ is a function of the variable λ.

This representation of the Cauchy problem (2) reflects a "soft" economic-mathematical model. Focusing on the functions $\alpha(\lambda)$ in the "soft" economic-mathematical model, we note the possibility of their application for a wide class of models. This is the property of the "soft" model. That is, it is possible to form conclusions with distinct functions $\alpha(\lambda)$. Thus, the conclusions are valid for any "soft" model, and there is no need to use special "hard" models (Kvitka, 2020).

Analysis of equation (2) shows that this is a first-order differential equation with separable variables, which has an analytical solution (Martynenko, O. V. & Mischenko, I. V., 2019, Popov, O. O. & Kovach, V. O., 2018).

To solve equation (2), we separate the variables and integrate, taking into account the initial condition:

$$\int_{I_0}^{I} \frac{dI}{I} = -\int_0^{\lambda} \alpha(\lambda) d\lambda. \quad (3)$$

After potentiation (3), we find

$$I = I_0 \cdot e^{-\int_0^{\lambda} \alpha(\lambda) d\lambda} \quad (4)$$

In the first step of the study, it makes sense to represent the dependence of the parameter in linear form, that is:

$$\alpha(\lambda) = a + b \cdot \lambda, \quad (5)$$

where a and b are constant parameters.

Substituting (5) into formula (4) and integrating, we successively find:

DOI: 10.55643/fcaptp.5.64.2025.4852

a i b - constant parameters.

$$I = I_0 \cdot e^{-\int_0^{\lambda}(a+b\cdot\lambda)d\lambda},$$

$$I = I_0 \cdot e^{-\lambda(a+b\cdot\frac{\lambda}{2})}. \quad (6)$$

The presented analytical dependencies became the basis for further research.

RESULTS

An enterprise that carries out its activities in conditions of technogenic pollution has the corresponding features inherent in the corresponding financial activity. The social component, which is a latent derivative of the impact of technogenic pollution on the cost-target indicators of the enterprise's functioning, should not be neglected (Konenko, V. V., 2020). In practice, as a means of combating the negative impact of the external environment, means are used that are based on appropriate sanctions to counteract the destructive effects of technogenic conditions. Effective activity of the enterprise involves obtaining the highest possible profits. For enterprises that carry out their activities in technogenic conditions, there is a need to take into account the features inherent in the financial components. We note that taking into account the limitations caused by the characteristics of the production of the relevant enterprise.

The presented research focuses on studying the impact of man-made pollution on the financial performance of an enterprise.

The obtained analytical dependence (6) contains a considerable number of parameters. The use of simulation modeling in relation to the processing of the presented dependence is a complicated procedure. This is explained by the separation of the parameters included in the formula (6). To solve this problem, it is advisable to use dimensionless components. The application of the similarity theory allows us to determine the directions of using dimensionless complexes. According to this theory, there is a possibility to reduce the number of parameters in comparison with the initially defined relation. Due to the appropriate transformations, the parameters and variables are grouped into dimensionless complexes. These complexes are formed through products. The parameters and variables defined in the original analytical representations are the multipliers of the products. The use of the multiplicative form of the representation of the specified function makes it possible to reduce the volume of calculations. This is explained by the possibility of replacing a significant number of parameter values with one value of the dimensionless complex represented in the multiplicative form. The corresponding dimensionless representation (6) will be represented as:

$$\hat{I} = e^{-(1+c\cdot\theta)\cdot\theta}, \quad (7)$$

where $\hat{I} = \frac{I}{I_0}$, $\theta = a \cdot \lambda$, $c = \frac{b}{2a^2}$.

It should be noted that formula (8), which is represented by dimensionless complexes, contains fewer parameters than the analogous analytical expression (6). In fact, formula (6) has four parameters:

(I_0, a , b , λ), and formula (7) has two parameters: (θ,c).

The representation of formula (7) allows us to investigate it quite simply as a function.

Further investigation involves the processing of function (8). To do this, we will determine its maximum with respect to θ. The calculation is based on the definition of the derivative, namely:

$$\frac{d\hat{I}}{d\theta} = -e^{-(1+c\cdot\theta)\cdot\theta} \cdot (1 + 2c \cdot \theta) \quad (8)$$

Further, according to the necessary condition for the existence of an extremum, we equate the derivative (8) to zero:

$$-e^{-(1+c\cdot\theta)\cdot\theta} \cdot (1 + 2c \cdot \theta) = 0,$$

and we find:

$$\theta_0 = -\frac{1}{2\cdot c} . \quad (9)$$

To determine the nature of the extremum of function (7), we use the sign of the second-order derivative at the value of the argument (9). The second-order derivative is found as the derivative of the first-order derivative (8):

$$\frac{d^2\hat{I}}{d\theta^2} = e^{-(1+c\cdot\theta)\cdot\theta} \cdot (1 + 2c\cdot\theta)^2 - e^{-(1+c\cdot\theta)\cdot\theta} \cdot 2c,$$

$$\frac{d^2\hat{I}}{d\theta^2} = e^{-(1+c\cdot\theta)\cdot\theta} \cdot ((1 + 2c\cdot\theta)^2 - 2c). \quad (10)$$

We find the value of the second-order derivative (10) at the stationary point (9)

$$\frac{d^2\hat{I}(\theta_0)}{d\theta^2} = e^{-(1+c\cdot\theta_0)\cdot\theta_0} \cdot ((1 + 2c\cdot\theta_0)^2 - 2c),$$

$$\frac{d^2\hat{I}(\theta_0)}{d\theta^2} = -2c \cdot e^{\frac{1}{4c}}. \quad (11)$$

The sign of the derivative (11) is determined by the sign of the parameter c, that is:

$$sign\left(\frac{d^2\hat{I}(\theta_0)}{d\theta^2}\right) = -sign(c) \quad (12)$$

Thus, if $c < 0$, then according to (12), the sign of the derivative (11) will be positive, which is a confirmation of the existence of a minimum of the function (7).

The minimum value of the function (8) is determined as the result of substituting the argument (9) into it:

$$\hat{I}_{min} = e^{\frac{1}{4c}} \quad (13)$$

Figure 1 presents graphs of function (7), which are calculated for different values of the parameter c.

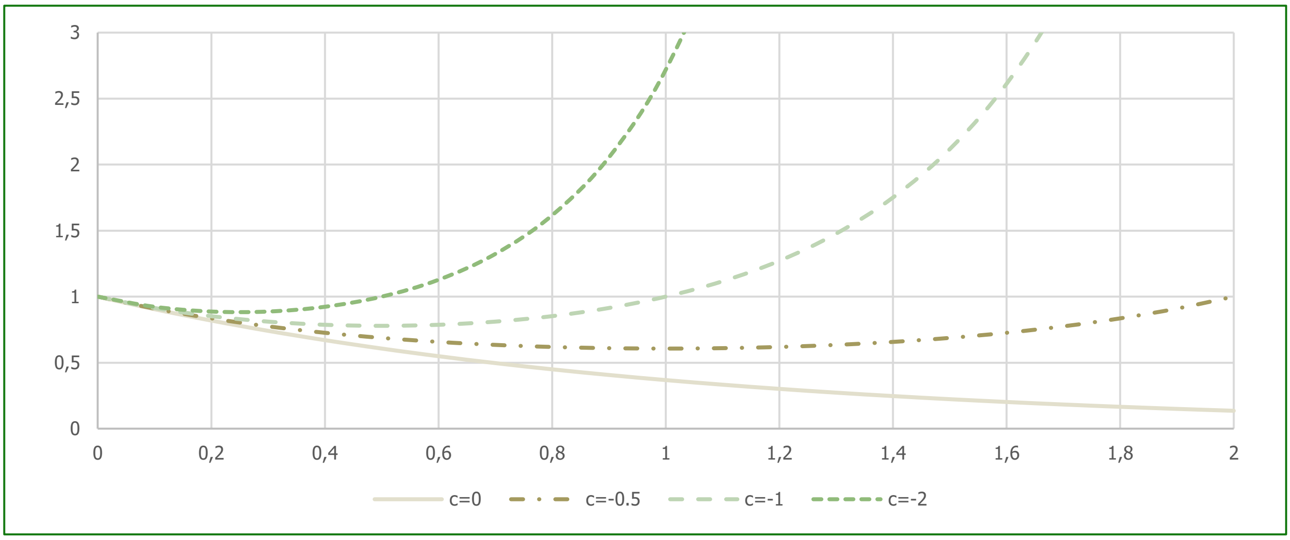

Figure 1. Dependence of income values on the value of technogenic self-pollution for different values of the parameter c.

Visualization of the graphical representation of the function (7) proves the unimodality of the functions with respect to different values of the parameter c. Thus, the value of the parameter c does not affect the qualitative characteristics of the obtained graphs. This indicates the structural stability of the graphs and accordingly, gives grounds to apply "soft" economic and mathematical models. Assuming the constancy of income from technogenic pollution, income losses decrease exponentially. This case corresponds to the "hard" mathematical model (c =0). The behavior is completely different when c≠0, for the case of the "soft" mathematical model. That is, the dependence of income on technogenic self-pollution. When the impact of technogenic pollution decreases, which corresponds to a decrease in the negative value of the parameter c, income initially decreases to some minimum value, which is determined by the values in (9) and (13), respectively. Then it begins to grow, which is confirmed by the behavior of the corresponding graphs presented in Figure 1.

DOI: 10.55643/fcaptp.5.64.2025.4852

According to the basic definition, to determine the profit from technogenic self-pollution, it is necessary to form an economic and mathematical model of costs for reducing technogenic self-pollution. General assumptions about a directly proportional dependence on the rate of increase in costs for reducing technogenic self-pollution. This creates a basis for building an economic and mathematical model of costs aimed at reducing technogenic pollution. It is advisable to present such a model as the Cauchy problem.

$$\begin{cases} \frac{dE}{d\lambda} + \beta \cdot E = 0 \\ E(\lambda = 0) = E_0 \end{cases}, \quad (14)$$

where β *– is the parameter, year,* E_0*– costs necessary to eliminate technogenic self-pollution, conventional units.*

The resulting differential equation in the Cauchy problem (15) is a linear equation of the first order. That is, there is a possibility to apply the corresponding analytical solution. For this differential equation (14), we separate its variables, successively writing it in the form:

$$\frac{dE}{d\lambda} + \beta \cdot E = 0, \frac{dE}{d\lambda} = -\beta \cdot E, \frac{dE}{E} = -\beta \cdot d\lambda. \quad (15)$$

Further, to obtain the general solution of equation (14), we integrate the last equality in (15) term by term:

$$\int \frac{dE}{E} = -\beta \cdot \int d\lambda,$$

$$ln\, E = -\beta \cdot \lambda + C, \quad (16)$$

where C *- is an arbitrary constant.*

To find an arbitrary constant, we use the initial condition of the Cauchy problem (14)

$$ln\, E_0 = -\beta \cdot 0 + C,$$

$$C = ln\, E_0. \quad (17)$$

Next, we substitute (18) into the general solution (16)

$$ln\, E = -\beta \cdot \lambda + ln\, E_0. \quad (18)$$

Using the properties of the logarithm of a function, we consistently obtain:

$$ln\, E - ln\, E_0 = -\beta \cdot \lambda,$$

$$ln\left(\frac{E}{E_0}\right) = -\beta \cdot \lambda,$$

$$\frac{E}{E_0} = e^{-\beta \cdot \lambda},$$

$$E = E_0 \cdot e^{-\beta \cdot \lambda}. \quad (19)$$

Parameters β in the analytical form are represented by (19) - a constant value. Therefore, we can conclude that expression (19) is a "rigid" mathematical model.

Figure 2 shows graphs of the function (19) for different values of the parameter β.

Visualization of the graphs in Figure 2 gives grounds to argue that reducing technogenic self-pollution requires increasing costs. Moreover, with an increase in the parameter β, the rate of growth of costs increases.

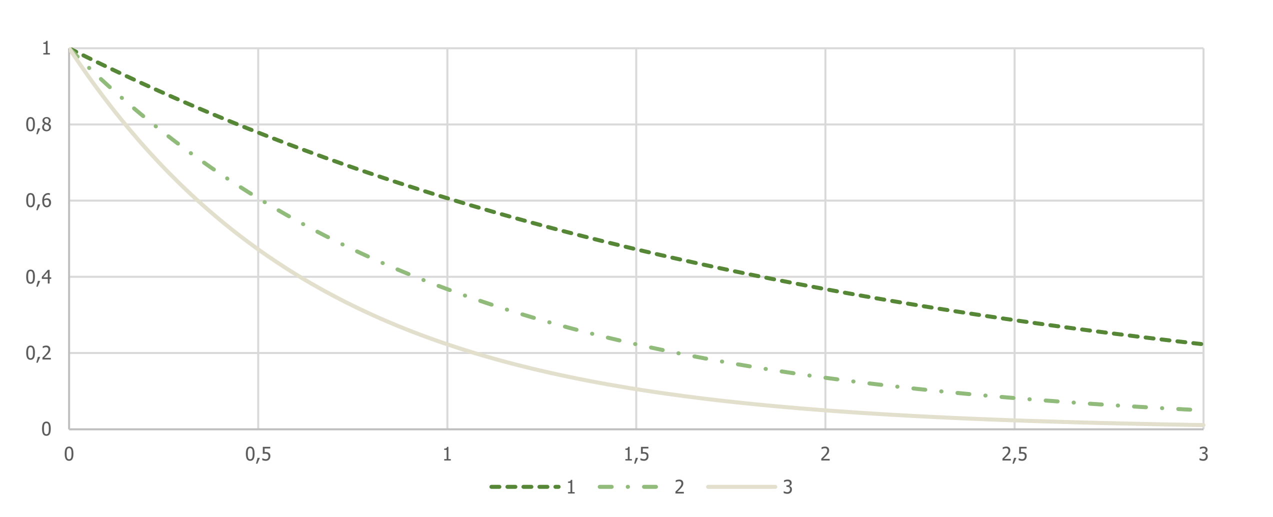

Figure 2. Schedule of costs for technogenic self-pollution for different parameters β. Note: E_0= 1; 1– β=0.5; 2 – β= 1; 3 – β= 1.5.

Taking into account formulas (7) and (19), the profit ($\hat{P}$) will be determined as:

$$P = I_0 \cdot e^{-(a+\frac{b}{2}\cdot\lambda)\cdot\lambda} - E_0 \cdot e^{-\beta\cdot\lambda}. \quad (20)$$

Applying the similarity theory method, we consider it appropriate to conduct further research based on the basic provisions of this theory. Thus, we can present formula (20) in a dimensionless form. We obtain:

$$\hat{P} = e^{-(1+c\cdot\theta)\cdot\theta} - \hat{E}_0 \cdot e^{-\gamma\cdot\theta} \quad (21)$$

where $\hat{P} = \frac{P}{I_0}$, $\hat{E}_0 = \frac{E_0}{I_0}$, $c = \frac{b}{a^2}$, $\theta = \lambda \cdot a$.

Figure 3 shows, in dimensionless form, graphs of income $\hat{I}$, expenses aimed at reducing technogenic self-pollution $\hat{E}$, and profit $\hat{P}$. Visual analysis of the profit graph (21), which is presented in Figure 3, shows that at a certain value of technogenic self-pollution, a minimum value of profit occurs.

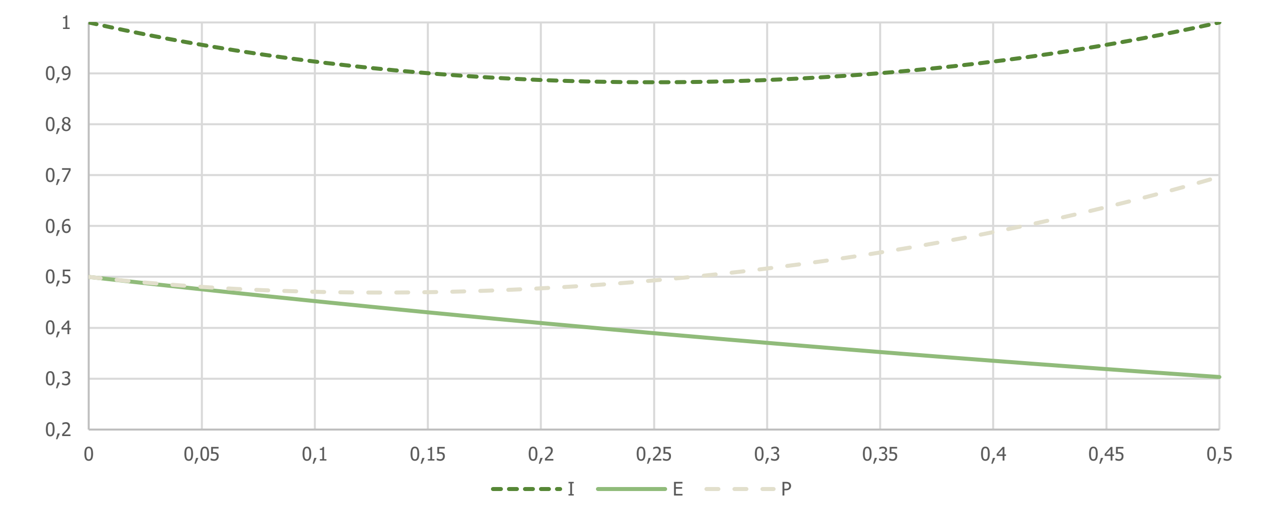

Figure 3. Dependence of income, expenses aimed at reducing technogenic self-pollution, and the corresponding profit. Note: $\hat{E}_0$= 0,5; c=-2; γ =1.

To find the optimal value of technogenic self-pollution, we determine the minimum of the function (22). with the values of the parameters $\hat{E}_0$= 0,5; c=-2; γ =1.

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As a result, the values were obtained:

$$\theta_{opt} = 0.129. \quad (22)$$

To obtain the minimum value of the profit, it is necessary to substitute (22) into formula (21). We obtain:

$$\hat{P}_{min} = \hat{P}(\theta_{opt}) = e^{-(1+c\theta_{opt})\theta_{opt}} - \hat{E}_0 e^{-\gamma\theta_{opt}}. \quad (23)$$

Substituting (22) into formula (23), we obtain the minimum profit value:

$$\hat{P}_{min} = \hat{P}(\theta_{opt} = 0.129) = 0.469 \quad (24)$$

Using formula (21), we will ensure the transition to dimensional quantities. Thus, we obtain:

$$I = \hat{I} \cdot I_0 \text{ , } P = \hat{P} \cdot I_0 \text{ , } E_0 = \hat{E}_0 \cdot I_0, \ c = \frac{b}{2a^2},$$

$$\lambda = \frac{\theta}{a} \text{ , } \beta = \gamma \cdot a. \quad (25)$$

Then the analytical expression for the amount of profit in a functional dependence on the amount of technogenic self-pollution has the following form:

$$P = I_0 e^{-(a+0.5\cdot b\cdot\lambda)\cdot\lambda} - E_0 \cdot e^{-\beta\cdot\lambda}. \quad (26)$$

In turn, the minimum profit value depending on the amount of technogenic pollution according to (26) and taking into account that

$$\lambda_{opt} = \frac{\theta_{opt}}{a}, \quad (27)$$

It will look like this:

$$Popt_0{}^{-(a+0.5\cdot b\cdot\lambda_{opt})\cdot\lambda_{opt}}{}_0{}^{-\beta\cdot\lambda_{opt}}{}_{min}. \quad (28)$$

Thus, setting the parameter values:

$$I_0, E_0, a, b, \beta, \quad (29)$$

According to formula (28), it is possible to calculate the corresponding value of technogenic self-pollution at which the profit value will be optimal. In turn, according to formula (27), it is possible to find the minimum profit value. It is clear that for a given profit value, the following condition must be met:

$$0 \le \lambda < \lambda_{opt}. \quad (30)$$

As an example, for the practical use of the obtained results, we will use the corresponding data on the values of the parameters (28):

$$I_0 = 100 \ E_0 = 50, \ a = 0.5, \ b = -1, \beta = 0.5 \quad (31)$$

Substituting (22) into formula (27), taking into account (31), we find the optimal value of technogenic self-pollution:

$$\lambda_{opt} = 0.258. \quad (32)$$

In turn, the minimum profit value according to (29) will be:

$$P_{min} = 46.92 \quad (33)$$

DOI: 10.55643/fcaptp.5.64.2025.4852

Thus, if condition (30) is met, the profit will increase.

Figure 4 graphically presents the functional dependence of profit on technogenic self-pollution under the condition of inequality (30).

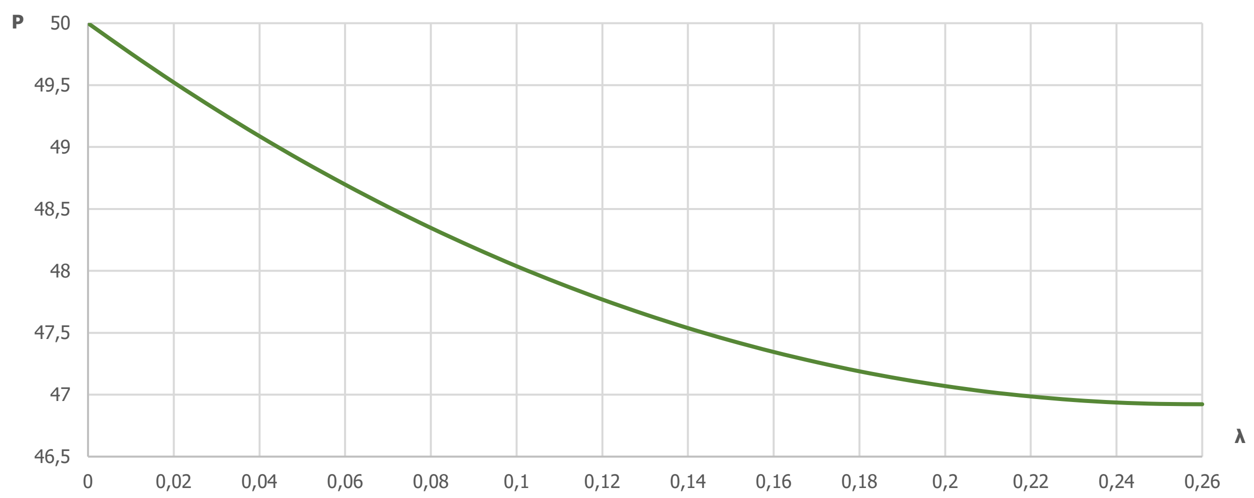

Figure 4. Graph of the dependence of profit on technogenic self-pollution according to condition (30). Note: calculated by formula (26), taking into account the values of parameters (31).

According to the graph shown in Figure 4, a given value of technogenic pollution λ, which satisfies condition (31), corresponds to a certain value of profit, which is calculated by the corresponding formula. Considering the decreasing nature of the change in the graph in Figure 4, we can conclude that the calculated value of profit will be greater than the minimum value of profit (33).

It should be noted that the social component is a derivative of the financial results of the enterprise. It is generally known that the social component of the enterprise is the amount of money that the enterprise spends on the social needs of its employees, as well as on social projects and initiatives aimed at improving the life of the community. To calculate the social component, it is necessary to take into account various factors, such as the amount of wages, the number of employees, their social needs, as well as social initiatives that the enterprise supports. All of the above factors are present in the financial results of the enterprise; therefore, we consider it possible to take into account the social component in the studies. For example, at PJSC "Kryvbaszalizrudkom", the deduction for social events was: 2021 – UAH 296982 thousand; 2022 - UAH 300329 thousand.

The authors Kotler, Lee, Philip, and Nancy emphasizes "...the concept of the 'triple criterion' is of extreme importance in the field of business social responsibility, which includes expanding the boundaries of organizational reporting and adding social and environmental aspects to financial performance indicators..." (Kotler, Lee, Philip, Nancy, 2005).

DISCUSSION

Modern industry, having high-tech components, affects not only economic processes in the state, but also the ecological and social components.

The analysis of scientific views in the presented area allowed us to determine the following. Scientists pay most attention to technogenic conditions in a specific region, without generalizing the relevant processes (Pihulevsky, P. G., Podrezenko, I. M., Anisimova, L. B., and Tyapkin, O. K., 2020; Khorolsky V. P., Khorolsky, K. D., and Kvitka, T. V., 2019, Popov, O. O. and Kovach, V. O., 2018, Nevolnychenko, A. I., Chumachenko, S. M., Mykhaylova, A. V., Pyrikov, O. V. and Murasov, R. K., 2022) and others. It should be noted that providing the ability to abstract technogenic processes will allow adapting fuses to the technogenic environment. It is proposed to use the methodology of economic and mathematical modeling to generalize the analysis of technogenic processes. The application of the methodology for forming the financial component of enterprises operating in technogenic conditions has received further development.

The attention of scientists has also been paid to the value-target processes related to the context of technogenic components. Without diminishing the importance of scientific achievements, it should be noted that the studies are not sufficiently

DOI: 10.55643/fcaptp.5.64.2025.4852

focused. Most of the publications are aimed at improving business processes. At the same time, the issue of the influence of technogenic components on the financial results of the enterprise is not considered. Therefore, it is proposed to show the relationship between the financial results of the enterprise and the technogenic environment through the formation of an economic and mathematical model. Kvitkoy T. V. suggests a direction for the formation of a methodology for building "soft models" in the direction of analyzing technogenic conditions of the enterprise's activity. The author obtained a corresponding model that has general theoretical approaches (Kvitka T. V., 2020). The author presents an interesting solution for the formation of a soft mathematical model that connects the influence of technogenic conditions on the profit and income of the enterprise. Generalizing analytical indicators, the author proposes to use dimensionless quantities, but the essence of the transition to quantitatively determined indicators is not determined. In the presented study, the authors determine the stages of the transition from dimensionless quantities to quantitatively determined ones. In addition, the importance of the synergy of environmental standards and the financial component of the enterprise is proven. This made it possible to determine the optimal value of technogenic pollution. The question of the type of economic and mathematical model of the financial component of an enterprise operating in technogenic conditions remains debatable. The analysis of scientific primary sources also indicates the absence of such a concept as self-pollution. It is proposed to determine enterprises that are a source of technogenic pollution - self-pollution.

The etiology of the consequences of social responsibility of business directly affects the financial results of the enterprise and the environmental component. When studying the activities of the enterprise in the synergy of the financial and environmental components, it is impossible to separate the social responsibility of business processes. In addition, the lack of a single unified economic and mathematical model of the enterprise's activities in technogenic conditions encourages further development of the modeling methodology, taking into account the effectiveness of the implementation of modern environmental technologies.

CONCLUSIONS

The conducted research confirmed the presence of peculiarities of the enterprise's activity in technogenic conditions. A definition of self-pollution for enterprises that are a source of pollution is proposed. The parameters by which the corresponding profit value can be calculated are determined; these are: income in the absence of technogenic self-pollution; costs necessary for the elimination of technogenic self-pollution; intensity of technogenic self-pollution; and model coefficients. The obtained ranges of influence of the intensity of self-pollution allow determining the optimal value of profit. An example of calculation is given for the value of technogenic self-pollution $\lambda=0.258$, the minimum value of profit is $P_{min}=46.92$ units. The limits of technogenic self-pollution are determined by which financial indicators will increase. Thus, it is possible to determine their optimal value at a certain value of technogenic self-pollution.

In the process of economic and mathematical modeling, the application of a dimensionless approach to obtain optimal conditions for optimal financial indicators of the enterprise's activities in technogenic conditions is shown. The transition from dimensionless indicators to quantitatively dimensioned ones is analytically shown. The formed complex of economic and mathematical models regarding costs, revenues, and profits represents a synergy of the components of the enterprise's financial activities and the technogenic external environment. This provides the etiology of the effects in the process of combining the specified components.

Further research is advisable in the direction of building multifactor models. This would allow combining the components of the enterprise's sustainable development to ensure effective management actions. Further development of the methodology of economic and mathematical modeling regarding the activities of enterprises that are carriers of technogenicity will allow for determining and expanding the systematicity of the relevant research.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

FUNDING

The Authors received no funding for this research.

CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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МОДЕЛЮВАННЯ ФІНАНСОВИХ РЕЗУЛЬТАТІВ ДІЯЛЬНОСТІ ПІДПРИЄМСТВА В ПАРАДИГМІ СОЦІАЛЬНОЇ ВІДПОВІДАЛЬНОСТІ БІЗНЕСУ

У роботі досліджено та змодельовано процес формування фінансових результатів підприємства, що працює в техногенних умовах, на основі соціальної відповідальності бізнесу. Запропоновано розглядати техногенні умови, які формує безпосередньо саме підприємство, як самозабруднення. Сформована економіко-математична модель дозволила проаналізувати фінансові результати підприємства, що працює в техногенних умовах. Визначено оптимальне значення техногенного самозабруднення. Показано, що коли значення техногенного забруднення менші за оптимальне значення, прибуток підприємства зростає. Заміна окремих параметрів економіко-математичної моделі аналітичними комплексами дозволила застосувати безрозмірну форму на засадах теорії подібності. Це дозволило зменшити обсяг необхідних розрахунків під час дослідження. Доведено важливість синергії екологічних стандартів і фінансової складової підприємства в поєднанні зі складовою соціальної відповідальності бізнесу.

Розвинуто методологію формування економіко-математичного моделювання фінансової складової підприємств, що працюють у техногенних умовах. Показано можливість використання диференціальних рівнянь на якісному рівні. Це дозволило визначити доцільність застосування «м’яких» економіко-математичних моделей. Доведено, що існує оптимальне значення доходу підприємства при відповідному значенні техногенного забруднення, яке характеризується структурною стійкістю.

Економіко-математичне моделювання фінансових показників діяльності підприємства стосовно техногенного самозабруднення дозволило визначити, використовуючи безрозмірний підхід, оптимальні умови витратно-цільових складових. Проведене дослідження дає підприємствам інструмент для формування фінансової стратегії діяльності в техногенних умовах на основі соціальної відповідальності.

Ключові слова: підприємство, м’яка модель, техногенні умови, соціальна відповідальність, фінансова звітність

JEL Класифікація: C19