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DEVELOPMENT OF MATHEMATICAL MODELS TO CALCULATE THE EFFECTIVENESS OF A DIGITAL PLATFORM FOR ENVIRONMENTAL MONITORING

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ABSTRACT

The prerequisites for the study are the formation of new forms of cooperation between enterprises and organizations, due to the development of digital management technologies, on the one hand, and the manufacturer's desire to minimize the number of transactions and reduce the resource supply of secondary functions by delegating their expansion to third-party companies as the market for high-tech products develops, on the other. Along with the advantage of new forms of business interaction in the form of digital platforms, there are several new problems associated with the emergence of various kinds of hindrances to their existence and development due to various risk factors specific to a particular economic agent and the formation of new value chains for customers. This, considering the diversity of participants in platform interaction, contributes to the emergence of inequality in terms of profit distribution. The purpose of the study formulated in connection with the above is to develop tools for the formation and regulation of effective platform interaction of environmental monitoring market entities in the form of mathematical models. Analysis, scientific abstraction, and modeling are used as research methods. It is proposed to compare platform interaction with cluster interaction in a vertical industry cluster with virtual infrastructure and digital platforms as a system-forming center. With this in mind, the concept of platform interaction in the environmental monitoring market is formed. Within the framework of the concept, mathematical models are developed to calculate the effectiveness of using a digital platform for environmental monitoring in the real sector of the economy for the buyer and the supplier. The proposed mathematical models serve as the basis for modeling the optimal cost of functions for running the digital platforms, developed by the Leading Research Center "Trusted Sensor Systems" of the National Research University of Electronic Technology.

Keywords: *Platform Interaction, Efficiency, Mathematical Model, Environmental Monitoring*.

1. INTRODUCTION

As the market develops, to focus on the production of products as the main function, minimize the number of transactions, and reduce the resource supply of secondary functions, the manufacturer delegates their expansion to third-party companies [1]. Following the concept of synchronization of marketing relations, it is assumed that (by analogy with the physical processes of oppositely charged particles moving away from each other), as the manufacturer moves away from the service and consumption spheres, there is a need to strengthen mutual ties between them [1, 2]. Simultaneously with the growth of the market, mutual connections are filtered, prompting the analysis and transformation of the organizational structure of the interaction of partners in the market of high-tech products, depending on its life cycle and considering existing needs [1].

The development of digital management technologies has contributed to the formation of new forms of cooperation between enterprises and organizations and the emergence of such a concept as "ecosystem" as a new way of describing the business environment in various sectors of the economy, including new technological industries [3].

Recently, platform interaction of market participants in various sectors of the economy has been increasingly developing in the context of the growth of scientific and technological progress, globalization, and digitalization of the economy [4-8].

Digital platforms (DP) in terms of institutional economics represent a new generation intermediary institution with various formats of interaction [9].

Considering the interdisciplinary directions of the development of economic theory and practice, which have led to a variety of opportunities and types of organization of joint activities of subjects of relationships, digital business ecosystems can be considered at the meso-level based on the same micro-foundations that form its methodological framework [10].

The variety of objects and subjects of economic, entrepreneurial, and production activities of participants in the digital business ecosystem causes the possibility of various kinds of hindrances to its existence and development, which is associated with a variety of risk factors specific to a particular economic agent [11].

Platform interaction at the nascent stage allows companies to minimize the costs of maintenance in the field of environmental monitoring. As platform interaction develops, this becomes possible at all stages of the market development lifecycle [1,12].

However, along with the advantage of new forms of business interaction in the form of ecosystems, several new problems arise associated with the emergence of new value chains for customers, which, considering the diversity of participants in platform interaction, contributes to the emergence of inequality in terms of profit distribution [13]. Given the insufficient adaptation of the regulatory system to new business conditions, this issue becomes especially relevant.

Despite several available publications on the organization of maintenance of technical systems, the problems of ensuring the effectiveness of platform interaction of market entities remain poorly studied.

In connection with the above, the purpose of the study was formulated, which is to develop tools for the formation and regulation of effective platform interaction of environmental monitoring market entities in the form of mathematical models.

The development's novelty is the formation of an approach to assessing the effectiveness of a DP for environmental monitoring in the real sector of the economy for the b-to-b segment. It is based on the systemic and balanced interaction of all DP participants and the development, based on the formed concept of platform interaction, of mathematical models. The models are intended for forecasting return on investment of a potential buyer and optimal distribution of profits between suppliers of functions and equipment for starting the DP, as well as determining the payback period of their investment. The models serve as the basis for testing the balance of the platform interaction system.

2. RESULTS

2.1 Results of the Formation of the Platform Interaction Concept

According to I. Mootee, basic requirements for platform technology should include the ability to perform one or more critical functions in a particular area; influence on the overall architecture of solutions and products with the definition of several standards; the possibility of development through network partnership due to the openness or semi-openness of the platform with admission to the participation of both suppliers of complementary goods and services and competitors [14, 15].

Analysis of sources [2, 12, 16] showed that platform interaction can be compared with cluster interaction in a vertical industry cluster with virtual infrastructure and DP as a backbone center.

Let us consider the possibility of applying elements of the concept of synchronization of marketing relations in the market of high-tech products, considering the stage of the life cycle of the market [2] concerning the participants of platform interaction in the environmental monitoring market.

Let us define the basic principles of forming the value proposition of a platform solution and how the consumer compensates for it.

1) The principle of mutual benefit of platform interaction participants

Platform interaction involves the synchronization of information and financial flows, helping to accelerate the entry of innovative products into the market for solution providers (technical, IT solutions, business solutions).

In cluster interaction, mutual benefits from interaction are facilitated by the possibility of using shared resources, which leads to minimizing financial and time losses of the participants in the relationship. In platform interaction, it is also assumed to obtain mutual benefits from interaction through the use of common resources (IT solutions, information resources) [17, 18].

Platform interaction provides for minimizing costs and/or losses for consumers of platform functions due to complementary and interchangeable functions and minimizing transaction costs [17-19].

2) The principle of balancing interaction through harmonization in conditions of economic instability.

One of the important components of harmonization is synchronization. The concept of platform interaction in the market of environmental monitoring of the producer with the spheres of consumption and service is to balance the flows of mutual influence between market participants by achieving mutual benefits from interaction [17, 18, 20].

3) The principle of synergy in terms of technology and function delegation.

Analysis of sources [2, 12, 21, 22] showed that the system property of integrativity, determined by the magnitude of system-forming or system-preserving factors, is one of the main ones in the conditions of cluster interaction. Therewith, the effectiveness of the organization of interaction between market entities depends on the correlability of their functions, which can be complementary, interchangeable, independent.

Complementary functions are usually different (heterogeneous) functions (for example, production and service). A necessary condition for determining the complementarity of two functions is the absence of at least one of them from one of the subjects of interaction.

Interchangeable functions are identical (homogeneous) functions involving the use of standardized resources (for example, service, transport). There is a synergistic effect due to minimizing costs as a result of sharing resources. Most often, interchangeable functions are not the main functions of the company.

Independent functions are usually identical (homogeneous) functions involving the use of non-standardized (individual, specific) resources, or specific functions that can be used only by one of the participants in the relationship [2].

Progressive systematization contributes to the emergence of synergy: due to the complementarity and interchangeability of functions, operational and management synergy is achieved; the joint use of resources and technologies contributes to the emergence of technological, resource, and infrastructural effects. All this helps to minimize the financial and time costs of the interaction participants and helps to accelerate the entry of high-tech products to the market [23].

With platform interaction, when choosing an integration model, customers are provided with their software for the DP, which, in turn, can be supplemented with data and related solutions from third-party developers. Therewith, the economic effect of platform interaction consists of compensation from customers for using extensible software due to integration by developers of their product or service. There is a reduction in costs due to functional optimization – reengineering of client and internal (servicing client) functions is carried out for their optimal automated execution.

The presence of an initial transformational effect in platform interaction contributes to improving the quality of the service provided, reducing transaction costs by expanding interaction with customers, and allows bringing innovative products and services with a complex monetization scheme to the market.

4) The principle of filtering and strengthening the mutual relations of the manufacturer with the service and consumption sectors.

The development of STP contributes to the growth of production of high-tech products and its complexity, which, in turn, causes an increase in requirements for the organization of the production process and sales service.

An analysis of the activities of various firms (according to domestic and foreign sources) shows that with the expansion of production and the territorial coverage of sales at the stage of market growth, it is advisable to delegate all or part of the service functions (logistics, service support, etc.) to intermediaries [1].

Following the concept of synchronization of marketing relations, it is assumed that (by analogy with the physical processes of oppositely charged particles moving away from each other), as the manufacturer moves away from the service and consumption spheres, there is a need to strengthen mutual ties between them [2]. The filtering of mutual connections that takes place encourages the analysis and transformation of the organizational structure of the interaction of partners in the market of high-tech products, depending on its life cycle and considering existing needs.

Platform interaction at the nascent stage allows companies to minimize the costs of maintenance in the field of environmental monitoring. As platform interaction develops, this becomes possible at all stages of the market development lifecycle.

5) The principle of replication of experience and effective exchange and distribution of knowledge in the context of multilateral relations.

The analysis of sources [5, 17] showed that the value in the DP is created due to platform interaction and competition of a set of diverse groups of DP participants. Therewith, DP participants receive a direct benefit from a larger number of users of the platform solution, and each side of the relationship.

The driver for the development of platform solutions in the process of implementing the main goal of platforms, which is the dissemination of technologies, is the desire to minimize costs.

Following Metcalfe's law, which provides that the utility of a network is proportional to the square of the number of its users, it should be expected that the diffusion of information and technology will contribute to the emergence of a network multiplicative effect.

6) The principle of consistency.

The principle of consistency involves evaluating the effectiveness of management by the effectiveness of the weakest link in the system. The conditions for achieving the effectiveness of the use of the platform in the real sector of the economy are to benefit each participant of the Platform from platform interaction.

The concept of platform interaction in the environmental monitoring market is presented in Figure 1.

2.2 Statement of the Economic Problem

The value of platform interaction can be represented as a direct value in the form of content, information, or/and the presence of other participants (customers). The key transaction of the platform is the interaction on the transfer of value from the seller to the buyer and compensation from the buyer to the seller.

The analysis of sources [19, 24, 25] showed that for production and network systems to cover the required volume of users, there is a need for basic provision, including special conditions of activity in the network, services for the formation of the initial number of users and subsequent differentiation of services and tariffs to influence the formation of favorable consumer expectations. When a critical mass is reached due to the actions of positive network externalities, the value of the information service increases for new participants in platform interaction.

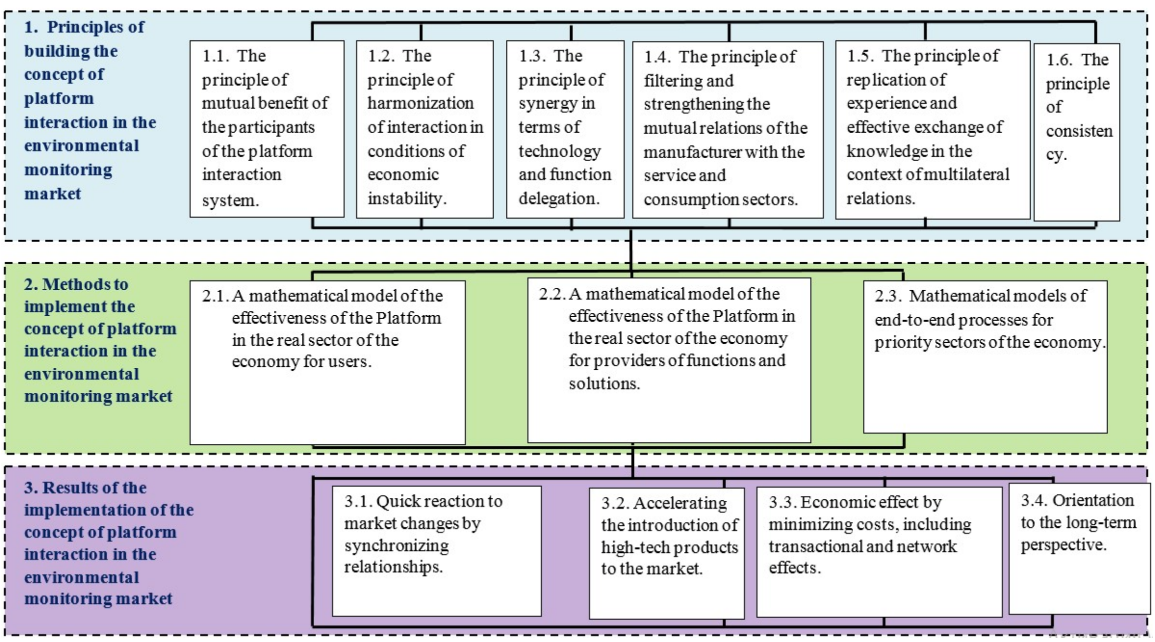

Figure 1: The Concept of Platform Interaction in the Environmental Monitoring Market

In the process of platform interaction, information or information-innovation rent is formed, obtained based on scientific knowledge, and appropriated by the owner-innovator, which is a monetary and another benefit (effect) distributed in time and space, obtained as a result of the development, implementation, accumulation, and replication of innovations at all levels and in all spheres of the physical and virtual space of the economy [19, 24]. The information and network economy is characterized by the predominance of information and innovation rent as part of the profit received by the owner of the DP. It forms an additional long-term integral effect in the form of

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factor income from the ownership and use of information and intellectual capital, capitalized innovations in the form of knowledge, information, intangible assets.

The efficiency of DP application in the real sector of the economy is determined based on the principle of consistency with the balanced interaction of all participants in platform interaction. The conditions for achieving the effectiveness of the use of the platform in the real sector of the economy are to benefit each participant of the DP from platform interaction.

Let us consider what benefits the participants of the platform interaction can receive on the digital environmental monitoring platform being created.

DP participants:

- Suppliers of equipment and/or functions;
- Buyers of equipment and/or functions;
- The owner of the platform.

The benefit of suppliers is to make a profit from the sale of equipment and/or functions to buyers, considering the investments made in the creation of DP, including by selling a license to RIA for the production of functions to other platform participants (for example, an industrial partner in a specific market segment). Performance indicators for suppliers: payback period T, profit in period T, discounted payback period, profit with discounting.

The benefit of buyers lies in obtaining economic profit from the purchase of equipment and/or functions from suppliers, obtained through savings in comparison with alternative solutions and /or by saving on the costs of risky events (fines, consequences of man-made disasters).

The benefit of the DP owner is to make a profit from the use of the DP by all participants of the platform interaction when buying and selling equipment and/or functions in the form of a commission percentage included in the price of equipment and/or functions, as well as in the form of royalties when using the transferred RIA licenses used in the production of equipment, functions. Performance indicators: payback period T, profit in period T, discounted payback period, profit with discounting.

2.3 Building Mathematical Models

One of the important features of mathematical models is the potential for their use to solve problems of different quality. Therefore, when solving a new economic problem, it is often possible to apply already known models.

A functional normative economic and mathematical model is most suitable for the economic problem posed, which is usually used to calculate balanced options for the development of the national economy that meet the final needs of society with planned production costs.

Let us consider the features of constructing mathematical models of the efficiency of using DP for environmental monitoring in the real sector of the economy for various participants of platform interaction.

Mathematical model of DP efficiency in the real sector of the economy for buyers:

- should allow evaluating the effectiveness of the use of DP in the real sector of the economy for buyers;

- evaluation of the efficiency of DP application considering discounting;

- calculation of the boundaries of the cost of the complex of functions F.

To build a mathematical model of the efficiency of DP use in the real sector of the economy, an analytical model that mathematically correctly reflects the relationship between input and output variables and parameters is most suitable for buyers.

Description:

k – the function number, $k \in K$;

f_k – function, $f \in F$;

c_k^f – the price of the function;

i-number of the buyer of functions and equipment, $i \in I$;

x_{ik} =1 if the i-th customer buys the function k, 0 – otherwise;

j – the number of the equipment resource for performing a set of functions F, $j \in J$;

m_j – a resource of equipment j for performing a set of functions F, $m \in M$;

c_j^m – the price of the equipment resource;

y_{ij} =1, if the i-th customer buys the equipment resource j, 0 – otherwise;

l – the number of the risk event, l € L;

r_l – risky event with an alternative execution of the functions F, $r \in R$;

c_l^r – the cost of losses from a risky event;

p_l – the probability of occurrence of a risk event, $p \in P$;

c_{it}^a – cost of alternative execution of functions F for the i-th client (interchangeable functions);

g – the number of the time period; g € G;

t_g – time period, t € T;

n_i – the number of points of the i-th client equipped with a set of equipment;

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γ_g – discount rate per year (period) t_g.

Conditions for the efficiency of DP use in the real sector of the economy for the i-th buyer:

$$\sum_{t_g=1}^{T} n_i * \left(\sum_k c_k^f * x_{ik} + \sum_j c_j^m * y_{ij}\right) < \sum_{t_g=1}^{T} \left(c_{it}^a + \sum_l c_l^r * p_l\right) \quad (1)$$

Including discounting:

$$\sum_{t_g=1}^{T} n_i * \left(\frac{\sum_k c_k^f * x_{ik} + \sum_j c_j^m * y_{ij}}{(1+\gamma_g)^{t_g}}\right) < \sum_{t_g=1}^{T} \left(\frac{\sum_l c_l^r * p_l + c_{it}^a}{(1+\gamma_g)^{t_g}}\right) \quad (2)$$

Efficiency criterion for the i-th buyer:

$$\sum_{t_g=1}^{T} \left(c_{it}^a + \sum_l c_l^r * p_l - n_i * \sum_k c_k^f * x_{ik} - n_i * \sum_j c_j^m * y_{ij}\right) \to max \quad (3)$$

T → *min*

Including discounting:

$$\sum_{t_g=1}^{T} \left(\frac{\sum_l c_l^r * p_l + c_{it}^a - n_i * \sum_k c_k^f * x_{ik} - n_i * \sum_j c_j^m * y_{ij}}{(1+\gamma_g)^{t_g}}\right) \to max \quad (4)$$

T → *min*

This mathematical model can be used to simulate the optimal cost of functions with $_k{}^f$ to start the DP. In the future, it can be used to predict the return on investment of a potential buyer, to calculate the recommended price of a new function for an existing/new function provider, to check the balance of the system of platform interactions.

Mathematical model of DP efficiency in the real sector of the economy for suppliers of functions and solutions:

- should allow evaluating the efficiency of DP application in the real sector of the economy for suppliers of functions and solutions;

- evaluation of the efficiency of DP application considering discounting;

- should allow automatically distributing profits among the participants of the DP.

In economics, optimization problems arise due to the multiplicity of possible options for the functioning of a particular economic object, when there is a situation of choosing the best option according to a certain rule, criterion characterized by the corresponding objective function (for example, to have a minimum of costs, maximum output).

Optimization models reflect the meaning of the economic problem in mathematical form. A distinctive feature of these models is the presence of a condition for finding an optimal solution (optimality criterion), which is written as a functional. These models, with certain initial data of the problem, allow obtaining a set of solutions that satisfy the conditions of the problem and provide the choice of the optimal solution that meets the optimality criterion.

To build a mathematical model of the efficiency of DP use in the real sector of the economy, linear programming is most suitable for suppliers of functions and solutions, which involves finding the extremum (maximum or minimum) of a linear function of many variables in the presence of linear constraints, i.e. linear equalities or inequalities connecting these variables. A wide range of issues of planning economic processes is reduced to the tasks of linear programming, where the task is to find the best (optimal) solution.

Description:

k – the function number, k ∈ K;

f_k – function, f ∈ F;

$c_k{}^f$ – the price of the function;

$v_k{}^f$ – the cost of the function;

i-number of the buyer of functions and equipment, i € I;

p-number of the supplier of functions and equipment, p € P;

b_p – supplier of p functions and equipment, b € B;

x_{ik} =1 if the i-th customer buys the function k, 0 – otherwise;

j – the number of the equipment resource for performing a set of functions F, j ∈ J;

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m_j is a resource of equipment j for performing a set of functions F, m € M;

c_j^m – the price of the equipment resource;

v_j^m – cost of equipment resource;

y_{ij} =1, if the i-th customer buys the equipment resource j, 0 – otherwise;

$Gp^{t'}$ – supplier p investment in the creation of the Platform in t_g year

g – the number of the period; g € G;

t_g – period, t € T;

t_g – period of investment, t' € N;

v_p^D – the cost of using the Platform/RIA, paid to the owner of the platform in the form of royalties;

w_p^D – profit from using the Platform;

γ_g – discount rate per year (period) t_g.

Conditions for the effectiveness of the Platform in the real sector of the economy for the supplier b_p:

$$\sum_{t=1}^{T}\left(\sum_{ik}(c_k^f - v_k^f) * x_{ik} + \sum_{ij}(c_j^m - v_j^m) * y_{ij} - v_p^D + w_p^D\right) > \sum_{t'=1}^{N} G_p^{t'} \quad (5)$$

Then the objective function of the problem will be presented in the following form:

Conditions for the effectiveness of the Platform in the real sector of the economy for the supplier b_p:

$$\sum_{t=1}^{T}\left(\sum_{ik}(c_k^f - v_k^f) * x_{ik} + \sum_{ij}(c_j^m - v_j^m) * y_{ij} - v_p^D + w_p^D\right) - \sum_{t'=1}^{N} G_p^{t'} \rightarrow max \quad (6)$$

Considering discounting:

$$\sum_{t=1}^{T}\left(\frac{\sum_{ik}(c_k^f - v_k^f) * x_{ik} + \sum_{ij}(c_j^m - v_j^m) * y_{ij} - v_p^D + w_p^D}{(1+\gamma_g)^t}\right) - \sum_{t'=1}^{N}\frac{G_p^{t'}}{(1+\gamma_g)^{t'}} \rightarrow max \quad (7)$$

Profit-sharing options:

– based on the investments:

$$\sum_p \alpha_p * G = G \quad (8)$$

– based on the achievement of payback.

To achieve the conditions of efficiency, it is necessary to choose the optimal values of profit distribution between suppliers of functions and equipment resources, considering the forecast for sales volumes (pessimistic, optimistic, optimal).

This mathematical model can be used to simulate the optimal distribution of profits between suppliers of functions and resources of equipment for running the DP, to determine the payback period. In the future it can be used to predict the payback of connecting to the DP of a new supplier, to check the balance of the system of platform interactions.

The basis for the construction of mathematical models of end-to-end processes for priority sectors of the economy will be based on institutional theory, a model of the potential difference of partners, development options, and the definition of network effects.

Following the institutional theory developed by Professor G.B. Kleiner [26], each Ins institution (organization) included in the institutional system Sins = {Ins} can be formally represented as a set of norms and their potential and real carriers:

$$Ins = ((N_0,D_0,R_0),(N_l,D_l,R_l),..,(N_k,D_k,R_k)), \quad (9)$$

where N_0 is the basic norm that makes up the core of the institution (there may be several such norms);

$N_{1\div}N_k$- "Support norms", acting as a supporting (reproducing) mechanism for the basic norm (including mechanisms of need);

D_i - is a potential carrier of the i-th norm, i = 0÷k;

R_i - is the real carrier of the i-th norm, i = 0÷k.

"Support norms" will include additional norms related to the "protective layer" of the institution; instructive (subsidiary) norms that determine the mechanisms for monitoring, control, and support of compliance with the norms of the core of the institution; cognitive norms, which are responsible for regulating the process of perception by various subjects of the essence and action of norms; value norms that form the general direction of assessments of this institution that are formed in the minds of people.

The institutions that make up the *Sins* country institutional system are interconnected to one degree or another; various relationships are formed between them:

1) Two institutions Ins and Ins', related to the given institutional system *Sins*, are identical when the composition of their norms, their potential and real carriers coincide (10).

$$\begin{cases} \{N_0,...,N_k\} = \{N_0',...,N_k'\} \\ \{D_0,...,D_k\} = \{D_0',...,D_k'\} \\ \{R_0,...,R_k\} = \{R_0',...,R_k'\} \end{cases} \quad (10)$$

2) Institutions of involvement include a family of institutions associated with the Ins institution, reflecting the attitude of each individual to the original institution or its substitutions in the form of participation in it, its recognition, rejection, etc. Are divided into:

- "institute of participation" – an institution the real carrier of which includes all persons involved in the functioning of the institute N_0;
- "institute of non-participation" is an institution that unites persons who are not fundamentally involved in these unions.

Such institutions can be called "flat" because their carriers are the primary elements of the socio-economic system in the form of individuals or legal entities, and all relations $N_0,...,N_k$ are unary, i.e. they are subsets of the set of agents A ($Di \subset Ri \subset A$).

3) The institutions of involvement include an institution, the carrier of which includes all agents involved in the activities of at least one of the institutions $N_0,...,N_k$, which are divided into three groups:

- persons having direct or indirect relation to this institution;
- potential participants of the institute;
- persons who are not included in the potential carrier of this institution.

4) Two institutions Ins and Ins' related to a given institutional system Sins can be considered close if they have the same supporting norms $N_1,...,N_k$ as relations, i.e. the existence of institutions Ins and Ins' is ensured by the same conditions.

These modeling tools are suitable for the formation of platform interactions between subjects of end-to-end processes for priority sectors of the economy.

3. DISCUSSION

There are different approaches to determining the effectiveness of DP.

In recent decades, the main topic of research in the field of evaluating the effectiveness of the functioning of multilateral and, including, DP has been the study of network effects [27-29] and pricing principles [25, 30].

Metcalfe's law [27] is more applicable to evaluating DP efficiency in the b-to-c market, according to which the value of any network for a user is equivalent to the square of the number of connection nodes, that is, if there are n users in the network, then the value of the network for each is proportional to the number of other users. In the b-to-b segment, which is not infrequently characterized by oligopoly along with legislative restrictions, this law will not always be applicable, at least when evaluating the efficiency of the DP for the buyer.

Several studies [24, 31] raise the question of the need to create an effective mechanism for the redistribution of value or value within the business ecosystem of the DP. Therewith, considering the complexity of such systems, the researchers refer to the theory of the "black swan", noting the impossibility of forming an accurate forecast of the development of business ecosystems, and, consequently, their management. In this case, it is proposed to assess the functioning of the business ecosystem according to three parameters: productivity, sustainability, and the creation of niches.

The model of formation of DP [32] solves the problem of minimizing the cost of DP development within the allocated budget but does not evaluate the effectiveness of DP use in the real sector of the economy.

In the framework of this article, it has been proposed to compare platform interaction with cluster interaction in a vertical industry cluster with a virtual infrastructure and DP as a system-forming center. With this in mind, the concept of platform interaction in the environmental monitoring market has been formed, within the framework of which an approach has been developed to assess the effectiveness of using a DP for environmental monitoring in the real sector of the economy based on the principle of consistency with balanced interaction of all participants in the DP. The proposed mathematical models will serve as a basis for modeling the optimal cost of functions for running the DP being developed. The leading research center "Trusted Sensor Systems" of the National Research University of Electronic Technology, forecasting the return on investment of a potential buyer, for modeling the optimal distribution of profits between suppliers of functions and resources of equipment for running the DP, to determine the payback period of their investments. In the future, they can be used to predict the payback of connecting to the DP of a new supplier, to check the balance of the system of platform interactions.

The program implementation and verification of the proposed mathematical models in the real sector of the economy are planned as further research.

The limitations of the application of the developed mathematical models include the lack of historical information, which can be compensated by modeling various options for the development of the DP.

4. CONCLUSION

The proposed mathematical models are designed to simulate the optimal cost of functions for starting the DP, developed by the Leading Research Center "Trusted Sensor Systems" of the National Research University of Electronic Technology, forecast the return on investment of a potential buyer, to model the optimal distribution of profits between suppliers of functions and resources of equipment for starting the DP, to determine the payback period of their investments, as well as to predict the payback of connecting to the DP of a new supplier and will serve as a basis for checking the balance of the system of platform interactions. Following the above, it can be concluded that the purpose of this study has been achieved.

The proposed concept of platform interaction in the environmental monitoring market and mathematical models for evaluating the effectiveness of the platform for environmental monitoring in the real sector of the economy will serve as the basis for the formation of a balanced mutually beneficial interaction of participants in various markets in the digital economy and business transformation.

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