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FORMING THE STRATEGIES OF SUSTAINABLE DEVELOPMENT OF FREIGHT FORWARDERS AT TRANSPORTATION MARKET

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ФОРМУВАННЯ СТРАТЕГІЙ СТАЛОГО РОЗВИТКУ ЕКСПЕДИТОРСЬКИХ ПІДПРИЄМСТВ НА ТРАНСПОРТНОМУ РИНКУ

Purpose. Development of theoretical bases for forming the strategies of freight forwarders' sustainable development for their operation under conditions of transport service market.

Methodology. Using the principles of a systematic approach and based on the apparatus of the sets theory, a model of the market of freight forwarding services was proposed. On the basis of the results of sustainable development paradigm analysis the indicators of sustainable development for freight forwarding companies were suggested. The task of forming strategies for sustainable development of transport and forwarding companies was formulated within the developed transport market model, basing on the conceptual apparatus of game theory.

Findings. A model of the freight forwarding service market was developed, which allows formalizing demand for transport services, as the characteristics of the material, financial and information flows circulating in the logistics system. Numerical operational and economic parameters were picked out to describe the indicators of sustainable development of freight forwarding companies. In the game model for the formation of forwarding companies strategies, the payoff function was formalized which, on the one hand, is determined on the basis of the numerical parameters of demand, and, on the other hand, it includes numerical characteristics of sustainable development indicators for the company. A methodology was proposed to ensure the practical implementation of the developed principles for the formation of sustainable development strategies of forwarding companies.

Originality. In the paper for the first time an approach is proposed to the formation of behavioral strategies of forwarding companies in the transport service market environment which, as opposed to existing ones, allows determination of strategies ensuring sustainable development of enterprises.

Practical value. The developed model is theoretical basis for experimental studies, which aim at the determination of the freight forwarding companies behavior strategies ensuring their sustainable development.

Keywords: *forwarding company, sustainable development, behavioral strategy*

Introduction. Behavioral strategies of forwarding companies operating in conditions of the stochastic environment of the transportation services market must comply with a set of business objectives, among which the main ones are the profitable way of operation, meeting customer needs for the cargo delivery, fulfillment of the requirements of existing legislation, as well as minimization of the harmful impact of transport on the environment.

Meeting the challenge of estimation of the freight forwarding companies' (*FFC*s) behavioral strategies requires an integration of the set of technical, economic and legal factors as well as the random effects of external transportation market environment on the technological processes of the transport enterprises. To solve this problem we define a set of indicators in this paper that characterize the sustainable development of freight forwarding companies, describe the macrologistical model of the transport market, and develop the method for determining the *FFC* strategies on the basis of the proposed system of indicators in the frame of the transportation market model.

Analysis of the recent publications. Determination of the optimal strategy of transport and forwarding companies' behavior has been considered in a number of recent papers [1–3]. The authors propose to form the strategies of transport and forwarding companies on different price [1, 2] and technological [3] levels.

For the price level in the paper [3] it is shown, that the payoff functions of the transport market participants could be defined in the following way

$$\begin{cases} H_{FF} = [S_{FF} + S_C \cdot (1 + R_C)] \cdot R_{FF} \\ H_{FO} = T - [S_{FF} + S_C \cdot (1 + R_C)] \cdot (1 + R_{FF}), \\ H_C = S_C \cdot R_C \end{cases}$$

where H_{FF}, H_{FO}, H_C are payoff functions of the *FFC*, freight owner and carrier respectively, \$/service; S_{FF}, S_C are costs of the forwarder and carrier services respectively, \$/service;

R_{FF}, R_C are rates of return for the *FFC* and the carrier respectively; T is the service price at the market, $/service.

With the use of the methodology of the games theory it was determined that for a conflict between the *FFC* and the cargo owner when setting a service fee, the best strategies for market participants could be evaluated by dependencies

$$\begin{cases} R_{FF}^{opt} = \dfrac{T - S_{FF} - S_C \cdot (1 + R_C)}{2 \cdot [S_{FF} + S_C \cdot (1 + R_C)]} \\ \delta_{opt} = \dfrac{S_{FF} + S_C \cdot (1 + R_C) - T}{2} \end{cases},$$

where R_{FF}^{opt} is the optimal value of the profitability rate set by the freight forwarder in the price of its services; δ_{opt} is the optimal strategy of the freight owner (the difference between the average market price of the services and the price paid by the enterprise), $/service.

For the conflict situation between *FFC* and carrier when setting a fee for the delivery service, the optimal strategies of the players (appropriate profitability rates R_C^{opt} and R_{FF}^{opt}) are evaluated in the following way

$$\begin{cases} R_C^{opt} = \dfrac{T_\delta - S_{FF} - S_C}{2 \cdot S_C} \\ R_{FF}^{opt} = \dfrac{T_\delta - S_{FF} - S_C}{T_\delta + S_{FF} + S_C} \end{cases},$$

where T_δ is the service fee, which was set for the freight owner, $/service.

The proposed game approach has been further developed to solve the problem of the strategies formation at the technological level for the servicing transport market actors (carriers and freight forwarders) [4]. In this case the payoff functions of forwarders and carriers are also proposed to be determined on the basis of the profitability level as the main indicator, which allows companies to describe their alternative strategies. It should be mentioned, that the profitability level reflects the economic and technological aspects of the servicing processes, however, it cannot be used in order to assess the no less important aspects of sustainable development of enterprises at the market of transport services – ecological safety of technological processes and the social component of the enterprises operation.

Unsolved aspects of the problem. Existing approaches to forming the optimal strategies of the *FFC* behavior allow estimating some separate indicators, which characterize their operation in the environment of the transport market. Sustainable development of technical, economic and social systems, such as freight forwarding enterprises, besides the technology and the service costs, supposes the definition of such strategic areas as resource saving, environmental safety and social component of the enterprise operation. At present, there are no formalized approaches that provide a tool for forming the strategies of the *FFC*s sustainable development.

Objectives of the article. To resolve the highlighted problem, it is necessary to develop the theoretical basis for forming the strategies of the sustainable development of forwarding companies under the conditions of their operation in the environment of the transport market. To achieve this objective in this article we describe a general model of the transport market operation, propose numerical characteristics of the *FFC* sustainable development indicators and develop a game model for forming the strategies of sustainable development of freight forwarders at the transportation services market.

Mathematical model of the transport market. The structure of the transportation services market could be considered as a set of subsystems, selected on a base of specific features [4–6]. The most obvious of these features are the type of elements (the type of the transport market subjects) and geographical location of the certain subjects. A set of the market subjects, selected by a regional feature, represents a logistics system of the appropriate region, which also could be considered as a certain macro logistics system containing subsystems, etc. The regions scale, defined by the appropriate subsystems, indicates the type of delivery implemented under the mediation of respective companies, which form the logistics system, in the cities, suburban, intercity or international deliveries.

Subsystems of the transport market system are the market subjects – freight forwarders FF_n, $n = 1...N$, carriers C_m, $m = 1...M$, and freight owners FO_k, $k = 1...K$. Collections of elements of the same type form the corresponding sets

$$\begin{cases} S_{FF} = \{FF_1, FF_2, ..., FF_N\} \\ S_C = \{C_1, C_2, ..., C_M\} \\ S_{FO} = \{FO_1, FO_2, ..., FO_K\} \end{cases},$$

where S_{FF}, S_C, S_{FO} are sets of all the forwarders, carriers and freight owners at the transport services market respectively.

The reason of interactions between the market subjects (subsystems) is the freight owners' needs for the movements of goods, on the one hand, and the carriers' needs for orders for deliveries, on the other hand. Freight forwarding is a process of meeting the needs of carriers and freight owners. Requests for freight forwarding (demand) and the process of their servicing form the flows, which connect elements of the system. Freight forwarding process is provided by the flows of three types, which circulate between the system elements – material, informational and financial flows.

The indicators, characterizing the material and information flows, are parameters of the flow of requests for freight forwarding services – requests from the freight owner to the forwarder (the need for forwarding services), from the carrier to the freight forwarder (the need for delivery requests) and from the freight forwarder to the carrier (a component of the technological process of the clients servicing). Parameters of the requests flows are described in [6] for each of the mentioned requests types.

Thus, the market of transport services M_{TS} could be presented as a collection of the mentioned objects

$$M_{TS} = \langle S_{FF}, S_{FO}, S_C, F_M, F_F, F_1 \rangle,$$

where F_M, F_F and F_1 are numerical parameters, which characterize material, financial and informational flows respectively.

Provided expression is a general model of the market of freight forwarding services.

In [6] it is proposed to describe material and related information and financial flows with a model of a flow of requests for transport services.

Within the framework of the market of the freight forwarding service system there could be distinguished the requests of outgoing flows (from the customers – the carriers and the freight owners) and incoming flows (requests to the forwarding companies). The basic unit forming the flow is the request for the services of *FFC*s. Each request could be characterized by a set of numeric parameters, among which the most significant are the cargo volume υ, the delivery distance λ and the request interval ζ (the time interval between adjacent requests in a flow).

For the request flow, the numeric parameters of requests are the stochastic values. Thus, the numerical characteristics, that describe the material, financial and information flows in macrologistical system of the transport service market, are the characteristics of random variables $\tilde{\upsilon}$, $\tilde{\lambda}$, $\tilde{\zeta}$, as well as market-based economic indicators taken as the deterministic values, – tariffs for the enterprises services, the cost of fuel and consumables, etc.

Indicators of the *FFC* sustainable development. The implemented analysis of contemporary paradigm of sustainable development with regard to technological systems (such as processes of the *FFC*'s clientele servicing) allows emphasizing the following indicators of forwarding enterprises' sustainable development:

- the use of productive resources of the forwarding enterprise in the process of its operation within the framework of the macrologistical system of the transport market;
- the impact of the results of the operation of forwarding companies on the environment;
- the social component of operation of a forwarding enterprise as a socio-economic system.

An indicator of the *FFC* production resources use is numerically defined by technical and economic indices of its operation. The main technical and operational parameters of a forwarding enterprise operation are performance of its employees involved in the process of customer service, and the level of service of the incoming requests' flow [6]. The main economic indicator of *FFC* operation is operating costs for customer service. The resulting operational and economic indicators of *FFC* operation depend, on the one hand, on the used servicing technology of the incoming request flow and the number of the forwarding enterprise dispatchers, and on the other hand, on the numerical characteristics of demand.

An indicator of the *FFC* operation influence on the environment is proposed to be estimated numerically with the specific level of the environment pollution. The environmental pollution with freight owners servicing in the first place is understood as air pollution by exhaust gases of vehicles. The pollution level could be estimated on the basis of the real demand parameters and the efficiency of the technology of the freight owners and carriers servicing, which is used by *FFC*.

It is obvious that the indicator of the social component of *FFC* operation should be evaluated numerically with the number of forwarding company employees. The amount of social security contributions paid by freight forwarding companies is directly proportional to the number of its employees. In turn, as it is shown in [6], the total number of *FFC* employees is determined by the number of dispatchers involved in the process of service of the incoming requests flow. Thus, as the main numerical index characterizing indicator of social component of *FFC* operation it is enough to use the number of the dispatchers.

Model for forming the *FFC* strategies. The activities of contemporary *FFC*s are mostly the intermediary activities, and therefore are characterized by conflicts arising as a result of the need to reconcile the interests of various parties [7]. Emanating from the content and features of the freight forwarding process, the statement could be made about the feasibility of using the apparatus of game theory to estimate the optimal strategies of *FFC*s in the transport market.

In [8] a game is defined as a conflict situation, and the game takes place, if the parties are identified, which are decision makers, the possibilities of the conflict actors are known (the set of all strategies), the outcomes of the conflict are defined (the situations), the parties defending some interests and the interests of the conflict actors (goals) are identified.

According to the game definition [8], the conflict situation $\Im$ formally could be presented in the following way

$$\Im = \left\langle \Re_a, \{r_K\}_{K\in\Re_a}, r, \Re_i, \{\succ_K\}_{K\in\Re_i} \right\rangle,$$

where $\Re_a$ is a set of all decision-making subjects (coalitions of actions in a game model); r_K is a set of all possible decisions (strategies) of game participants, who are responsible for decisions; r is a set of all situations (outcomes) of the game; $\Re_i$ is a set of all entities defending certain interests (coalition of interests); $\succ_K$ is a set of all interests of entities interested in the conflict (the preference relation).

All the outcomes of a game form a set *r*, which is a subset of a set of all combinations of strategies of the action coalitions

$$r \subset \prod_{K\in\Re_a} r_K.$$

It is generally accepted that the interests of the coalition are subsets of the same set of players that form the coalition of actions.

A set of all the interests $\succ_K$ is a binary relation on the set *r*

$$\succ_K \subset r \times r, \quad K \in \Re_i.$$

To determine the relation of preference on the set of situations, a function H_K is used, which is defined on a set of real numbers, – the payoff function of the coalition of interests *K* [9].

The task of choosing the optimal strategy of *FFC* behavior in transport market conditions in terms of game theory belongs to games with nature. When presenting this problem as a model, a set of players consists of two elements – forwarding company and transport services market (nature)

$$\Re_a = \left\{ FF^*, M'_{TS} \right\},$$

where FF^* is a forwarding company, for which the strategy of its behavior at the market is being formed; M'_{TS} is a part of the macro-logistics system of a transportation service market, which does not include the forwarding company FF^* ($M'_{TS} = M_{TS} \backslash FF^*$).

A set r_{FF} of all feasible decisions (strategies) of a forwarding company is defined as a set of all possible combinations for the following key parameters:

- N_D is a number of *FFC* dispatchers, involved in a process of the incoming requests flow servicing;
- is tariff for the provided services offered by the forwarding company to freight owners, $/ton-km;
- τ_{FF} is technology of the logistics chains (delivery routes) forming accepted by the forwarding company: using the standard tools of logistics portals or using the specialized information tools.

The set r_{FF} of the *FFC* strategies is defined as the Cartesian product of sets, containing the possible values for key parameters

$$r_{FF} = S(N_D) \times S(T_{FF}) \times S(\tau_{FF}),$$

where $S(N_D)$ is a set of possible values of a number of the *FFC* dispatchers, which serve the requests from clientele; $S(T_{FF})$ is a set of possible values of the tariff on the *FFC* services; $S(\tau_{FF})$ – a set of alternate variants of the technology used for the forming of the logistics chain structure (or delivery routes formation).

The set of the nature strategies (possible states of the transport market) in the context of the task of the *FFC* strategies formation could be defined as sets of possible values of the characteristics of demand for the forwarding company services – of the parameters of stochastic values for the cargo volume $\tilde{\upsilon}$, the delivery distance $\tilde{\lambda}$ and time interval $\tilde{\zeta}$ between the requests.

In accordance with the research [6] results, parameters of demand for freight forwarding services are random variables, such as the cargo volume and the delivery distance, as a rule, are distributed normally, and the request interval is usually characterized by exponential distribution. Numerical characteristics of the normally distributed variable are the location parameter (expected value) and the scale parameter (standard deviation), and the random variable with exponential distribution is characterized with the scale parameter – its mean value. Thus, the nature strategy D_{TM} (the state of the transport services market) is a set of the following values

$$D_{TM} = \langle \mu_\upsilon, \sigma_\upsilon, \mu_\lambda, \sigma_\lambda, \mu_\zeta \rangle,$$

where μ_υ, μ_λ and μ_ζ are mathematical expectations of the random variables of the cargo volume, the delivery distance and the request interval respectively, tons, km and hours; σ_υ and σ_λ are standard deviations of the random variables of the cargo volume and the delivery distance respectively, tons and km.

Then the set r_{TM} of possible states of the transportation service market could be defined as the following Cartesian production

$$r_{TM} = S(\mu_\upsilon) \times S(\sigma_\upsilon) \times S(\mu_\lambda) \times S(\sigma_\lambda) \times S(\mu_\zeta),$$

where $S(\mu_\upsilon)$ and $S(\sigma_\upsilon)$ are sets of possible values of the location and scale parameters respectively for the variable of the cargo volume; $S(\mu_\lambda)$ and $S(\sigma_\lambda)$ are sets of possible values of the location and scale parameters respectively for the variable of the delivery distance; $S(\mu_\zeta)$ is a set of possible values of the scale parameter for the variable of the request interval.

The payoff function in the presented game model while solving the problem of formation of strategies for the *FFC* sustainable development should reflect the numerical characteristics of sustainable development indicators – productivity of dispatchers, a level of the client service, total operating costs of *FFC* (characteristics of an indicator of the productive resources use), the level of environment pollution (characteristics of the environment impact indicator) and the number of *FFC* dispatchers (characteristics of the indicator reflecting the social component of the forwarding company operation). On the other hand, the payoff function should be determined by the numerical characteristics of the players' strategies – characteristics of an *FFC* and the transport market.

To solve the problem of formation of the sustainable development strategies, we propose to use the following payoff function that satisfies the described requirements

$$H = n_\Sigma \cdot U \cdot T'_{FF} - E_{op} - U_{ec},$$

where n_Σ is the overall number of requests from the forwarding company clientele; U is the level of the clientele service; T'_{FF} is the tariff for freight forwarding services, $/request; E_{op} – total operating costs of the forwarding company, $; U_{ec} is the level of environment pollution caused by transportation operations, $.

For the proposed formulation, the game model applies to the models characterized by a stochastic uncertainty. In the case of stochastic uncertainty each state of nature (the market of transport services) could be described by the corresponding probability of its occurrence. The optimal strategy r_{FF}^{opt} of the forwarding company in such a case is defined in the following way

$$r_{FF}^{opt} = \arg\max_{r_{FF}} \max_{i=1\ldots m} \sum_{j=1}^{n} \left(p_j \cdot H_{ij} \right),$$

where m is the number of possible *FFC* strategies; n is the number of possible states of the transportation services market; p_j – a probability of the market being in the j^{th} state; H_{ij} is a value of the payoff function for the case when *FFC* uses the i^{th} strategy and the market stays in the j^{th} state.

The use of the described mathematical apparatus for formation of the sustainable development strategies of forwarding companies is possible due to implementation of the following steps:

1. Study of demand parameters at the transport market: estimation of the numerical characteristics of random variables of the cargo volume, the delivery distance, and the request interval.

2. Substantiation of the numerical values of operational and economic parameters that characterize the process

of the forwarding company operation and are necessary to determine the resulting indicators of the technological process – duration of the requests processing and the operating costs for servicing the request flow as a whole.

3. Substantiation of intervals of the numerical parameters characterizing the forwarding company's strategy – the number of dispatchers involved in the processing of the incoming request flow, and the tariff on the *FFC* services.

4. Formation of the set of possible strategies of the forwarding company and of the set of possible states of the transportation service market.

5. Calculation of the matrix of the payoff function values and choice of the optimal strategy for sustainable development of *FFC* at the transport market.

It should be noted that since steps 4–5 are characterized by high labor intensity, it is advisable to develop specialized software in order to implement them.

Conclusions. As the basic indices, characterizing the sustainable development of the *FFC* at the transportation service market, we propose to use: the dispatchers' productivity, the service level and the operational costs in order to describe the indicator of the productive resources use; the environmental pollution level to define the indicator of the *FFC* operation influence on the environment; the number of dispatchers to describe the indicator of the social component of the forwarding company operation.

The proposed method for the formation of the *FFC* sustainable development strategies is based on the use of a game model. The conflict parties in the developed model are the forwarding company and the transportation service market (nature). As far as implementation of the proposed method of the *FFC* strategies formation is characterized by high laboriousness, for its practical use, the specialized software should be developed.

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Мета. Розробка теоретичних основ формування стратегій сталого розвитку експедиторських компаній при їх функціонуванні в умовах ринку транспортних послуг.

Методика. З використанням принципів системного підходу на базі апарату теорії множин запропонована модель ринку транспортно-експедиторських послуг. На підставі результатів аналізу парадигми сталого розвитку запропоновані індикатори сталого розвитку експедиторських підприємств. У рамках розробленої моделі транспортного ринку на базі понятійного апарату теорії ігор сформульована задача формування стратегій сталого розвитку транспортно-експедиторських компаній.

Результати. Розроблена модель ринку транспортно-експедиторських послуг, що дозволяє формалізувати попит на транспортні послуги як характеристики матеріальних, фінансових і інформаційних потоків, що циркулюють у логістичній системі. Виділені чисельні техніко-експлуатаційні й техніко-економічні показники, що дозволяють охарактеризувати індикатори сталого розвитку експедиторських підприємств. Формалізована функція виграшу в ігровій моделі формування стратегій експедиторського підприємства, що, з однієї сторони, визначається на підставі чисельних параметрів попиту, а з іншої – включає чисельні характеристики індикаторів сталого розвитку підприємства. Запропонована методика проведення робіт, що забезпечують практичну реалізацію розроблених принципів формування стратегій сталого розвитку для експедиторських підприємств.

Наукова новизна. У роботі вперше пропонується підхід до формування стратегій поведінки експедиторських підприємств у середовищі ринку транспортних послуг, який, на відміну від існуючих, дозволяє визначити стратегії, що забезпечують сталий розвиток підприємств.

Практична значимість. Розроблена модель є теоретичною базою для проведення експериментальних досліджень з метою визначення стратегій поведінки транспортно-експедиторських компаній, що забезпечують їх сталий розвиток.

Ключові слова: *експедиторське підприємство, сталий розвиток, стратегія поведінки*

Цель. Разработка теоретических основ формирования стратегий устойчивого развития экспедиторских компаний при их функционировании в условиях рынка транспортных услуг.

Методика. С использованием принципов системного подхода на базе аппарата теории множеств предложена модель рынка транспортно-экспедиторских услуг. На основании результатов анализа парадигмы устойчивого развития предложены

индикаторы устойчивого развития экспедиторских предприятий. В рамках разработанной модели транспортного рынка на базе понятийного аппарата теории игр сформулирована задача формирования стратегий устойчивого развития транспортно-экспедиторских компаний.

Результаты. Разработана модель рынка транспортно-экспедиторских услуг, позволяющая формализовать спрос на транспортные услуги как характеристики материальных, финансовых и информационных потоков, циркулирующих в логистической системе. Выделены численные технико-эксплуатационные и технико-экономические показатели, позволяющие охарактеризовать индикаторы устойчивого развития экспедиторских предприятий. Формализована функция выигрыша в игровой модели формирования стратегий экспедиторского предприятия, которая, с одной стороны, определяется на основании численных параметров спроса, а с другой – включает численные характеристики индикаторов устойчивого развития предприятия. Предложена методика проведения работ, обеспечивающих практическую реализацию разработанных принципов формирования стратегий устойчивого развития для экспедиторских предприятий.

Научная новизна. В работе впервые предлагается подход к формированию стратегий поведения экспедиторских предприятий в среде рынка транспортных услуг, который, в отличие от существующих, позволяет определить стратегии, обеспечивающие устойчивое развитие предприятий.

Практическая значимость. Разработанная модель является теоретической базой для проведения экспериментальных исследований с целью определения стратегий поведения транспортно-экспедиторских компаний, обеспечивающих их устойчивое развитие.

Ключевые слова: *экспедиторское предприятие, устойчивое развитие, стратегия поведения*

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SOCIAL AND ENVIRONMENTAL RESPONSIBILITY STRATEGIES OF BUSINESS

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СТРАТЕГІЇ СОЦІАЛЬНО-ЕКОЛОГІЧНОЇ ВІДПОВІДАЛЬНОСТІ ПІДПРИЄМСТВА

Purpose. The purpose of the article is to identify strategies for social and environmental responsibility of a company according to the existing business opportunities for implementing social and environmental responsibility and according to the readiness of an enterprise to introduce programs of social and environmental responsibility as well as to choose the strategic alternative according to the level of social and environmental security of the region in which the enterprise is located.

Methodology. The results were obtained with the following methods: matrix approach in creating a matrix of social and environmental responsibility strategies of a company; quantitative analysis in determining the capability of an enterprise to implement appropriate social and environmental responsibility; qualitative analysis in determining the readiness of a company to introduce these programs.

Findings. The authors proposed a list of criteria to identify the strategies for social and environmental responsibility of companies. Nine main strategies for social and environmental responsibility of companies were determined in the paper, namely, reactive, defensive, stabilization, minimum responsibility strategy, preventive, growth strategy, accommodative, capacity building, proactive. The authors proposed an algorithm to choose strategic alternatives according to the existing company's strategy of social and environmental security.

Originality. The authors suggested a two-level matrix of choosing the strategies for social and environmental responsibility of the enterprise according to the following:

1) basic selection criteria upon which it is possible to make conclusions regarding the available development strategy: the capabilities for the implementation of social and environmental responsibility programs as well as the readiness of enterprise to implement these programs;

2) criterion of strategic alternatives choosing, i. e. the level of social and environmental security of the region in which the enterprise is located. Based on this criterion, it is possible to draw a conclusion of prospects of an enter-