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Stakeholders' rank of reflexion diagnostics in a corporate social responsibility system

Abstract. The use of new methods and technologies for managing relations with stakeholders in a corporate social responsibility system, in particular the reflexive approach, forms the basis for increasing the effectiveness of socially responsible management. The category of «rank of reflexion» occupies a significant place in the methodology of reflexive management modelling. Reliable diagnostics of the stakeholders' rank of reflexion is one of the important areas increasing the efficiency of socially responsible decisions and actions in the process of reflexive management. The purpose of this paper is to substantiate the use of the fuzzy-logic method for diagnostics of the stakeholders' rank of reflexion and formulate types of reflexive management of corporate social responsibility depending on the rank and level of complexity. The authors substantiate that when applying methods of reflexive management in practice, in the long run, the ambiguity and variability of the stakeholders' rank of reflexion have to be taken into account. This corresponds to the system's properties of dynamism (B1), adaptability (B2) and structure (B3). Given that the existing apparatus of reflexive management takes into account mainly one-time influences, the article suggests using the fuzzy diagnostic method to determine the stakeholders' rank of reflexion.

There is a case showing formulation and solution of the problem of determining the stakeholders' rank of reflexion by using mathematical fuzzy logic. It is proved that the storage of the estimates of the stakeholders' reaction as fuzzy sets allows considering the conclusion of B3, giving opportunities for further analysis of patterns changing the stakeholder's rank of reflexion within the conclusions B1 and B2.

The results of the study show that the rank of reflexion increasing in the company promotes corporate social responsibility growth through a more effective interaction with the stakeholders. Five types of reflexive management of corporate social responsibility are proposed depending on the rank and complexity level of reflexion, used by the company's management, namely: defensive, compliance, managerial, strategic, and civil. The use of relevant reflexive influences as implementation tools of corporate social responsibility provides increasing efficiency of interaction with stakeholders. The prospects of the follow-up research on this topic should include the classification of the company's reflexive influences on the stakeholders.

Keywords: Corporate Social Responsibility; Stakeholder; Rank of Reflexion; Reflexive Management; Reflexive Games; Fuzzy Logic

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Метод діагностики рангу рефлексії стейкхолдерів
у системі корпоративної соціальної відповідальності

Анотація. Надійна діагностика рангу рефлексії стейкхолдерів є однією з важливих галузей, що підвищують ефективність соціально відповідальних рішень і дій у процесі рефлексивного управління. Метою даної статті є обґрунтування застосування методу нечіткої логіки для діагностики рангу рефлексії стейкхолдерів і визначення типів рефлексивного управління корпоративною соціальною відповідальністю в залежності від рангу рефлексії та рівня складності.

У більшості існуючих теоретичних досліджень в області рефлексивного управління розглядаються ідеальні випадки, коли суб'єкт рефлексивної взаємодії має певний ранг. У статті обґрунтовано, що при практичному застосуванні методів рефлексивного управління в довгостроковій перспективі необхідно враховувати неоднозначність і мінливість рангу рефлексії зацікавлених сторін. Це відповідає системним властивостям динамізму (В1), адаптивності (В2) і структури (В3).

З огляду на те, що існуючий апарат рефлексивного управління враховує головним чином разові впливи, у статті запропоновано метод для нечіткої діагностики рангу рефлексії зацікавлених сторін. Доведено, що зберігання оцінок реакції стейкхолдерів у вигляді нечітких множин дозволяє врахувати висновок В3 і дає можливість подальшого аналізу закономірностей у зміні рангу рефлексії стейкхолдерів у рамках висновків В1 і В2. Результати проведеного дослідження показують, що підвищення рангу рефлексії в компанії сприяє зростанню корпоративної соціальної відповідальності за рахунок більш ефективної взаємодії зі стейкхолдерами. Запропоновано п'ять типів рефлексивного управління корпоративною соціальною відповідальністю: захисний, спільний, управлінський, стратегічний і цивільний, що використовуються керівництвом компанії залежно від рангу й рівня складності рефлексії.

Ключові слова: корпоративна соціальна відповідальність; стейкхолдер; ранг рефлексії; рефлексивне управління; рефлексивні ігри; нечітка логіка.

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Метод диагностики ранга рефлексии стейкхолдеров
в системе корпоративной социальной ответственности

Аннотация. Надежная диагностика ранга рефлексии стейкхолдеров является одной из важных областей, повышающих эффективность социально ответственных решений и действий в процессе рефлексивного управления. Целью данной статьи является обоснование применения метода нечеткой логики для диагностики ранга рефлексии стейкхолдеров и определения типов рефлексивного управления корпоративной социальной ответственностью в зависимости от ранга рефлексии и уровня сложности. В большинстве существующих теоретических исследований в области рефлексивного управления рассматриваются идеальные случаи, когда субъект рефлексивного взаимодействия имеет определенный ранг.

В статье обосновано, что при практическом применении методов рефлексивного управления в долгосрочной перспективе необходимо учитывать неоднозначность и изменчивость ранга рефлексии заинтересованных сторон. Это соответствует системным свойствам динамизма (В1), адаптивности (В2) и структуры (В3). Принимая во внимание тот факт, что существующий аппарат рефлексивного управления учитывает главным образом разовые воздействия, в статье предложен метод для нечеткой диагностики ранга рефлексии заинтересованных сторон. Доказано, что хранение оценок реакции стейкхолдеров в виде нечетких множеств позволяет учесть вывод В3 и дает возможности для дальнейшего анализа закономерностей в изменении ранга рефлексии стейкхолдеров в рамках выводов В1 и В2.

Результаты проведенного исследования показывают, что повышение ранга рефлексии компании способствует росту ее корпоративной социальной ответственности за счет более эффективного взаимодействия со стейкхолдерами. Предложено пять типов рефлексивного управления

корпоративной социальной ответственностью: защитный, совместный, управленческий, стратегический и гражданский, используемых руководством компании в зависимости от ранга и уровня сложности рефлексии.

Ключевые слова: корпоративная социальная ответственность; стейкхолдер; ранг рефлексии; рефлексивное управление; рефлексивные игры; нечеткая логика.

1. Introduction

Today the company's competitive position is determined not only by its business and market achievements, but also by the perception of its activities by customers, employees, representatives of state and local authorities, local community, etc. The need to establish mutually beneficial relations with these groups of stakeholders is increasingly recognized by corporate management. It has become an essential element in the corporate social responsibility system.

The «stakeholder», or «interested party», is the central concept forming the conceptual-categorical apparatus of the stakeholder theory within the realm of corporate social responsibility (CSR). The first mention of this term can be found in Stanford research works in 1963. Stakeholders were defined as «those groups without whose support the organization would cease to exist» (as cited in Freeman, 2010). Donaldson and Preston (1995) noted that «stakeholders are identified through the actual or potential harms and benefits that they experience or anticipate experiencing as a result of the firm's actions or inactions». Mainardes, Alves and Raposo (2011) state that there is no single generally accepted definition of «stakeholders», however there are similarities between many of them, taking into account the needs and interests of those individuals or groups who affect, or can be influenced by the company's decisions and actions.

In their research Laplume, Sonpar and Litz (2008) reviewed 179 definitions of the stakeholders. Miles (2012) made even a more extensive review with 435 definitions. The most widespread definition of stakeholders is Freeman's definition as «any group or individual who can affect or is affected by the achievement of the organization's objectives» (Freeman, 2010).

In its ordinary course of business, the company faces interests of a large number of stakeholders which are usually divided into the following groups (Mazur & Pisarski, 2015; Koehler & Raithel, 2018):

· internal stakeholders, such as owners (shareholders), employees and management;
· external stakeholders, including customers, suppliers, competitors, local community, state and local regulatory authorities, financial institutions, public organizations, etc.

There are six primary stakeholders the firm depends on for its survival and continued success (Hult, Mena, Ferrell & Ferrell, 2011). They include customers, employees, suppliers, shareholders, regulators and the local community.

Ensuring the company's successful development in the long run is inextricably linked with the system work with priority stakeholder groups (Bourne, 2015; Looser & Wehrmeyer, 2015; Ackermann & Eden, 2011).

Within the stakeholder theory, it is the executive's job to manage and shape relationships with stakeholders to create as much value as possible for them (Parmar, Freeman, Harrison, Wicks, Purnell, & De Colle, 2010).

There is a growing interest in the information field related to methodological bases for managing stakeholder relations. According to R. Lepa (2014), traditional methods and approaches to stakeholder management are not always successful, and they do not take into account individualities of consumption, psychological aspects of economic processes. To overcome the growing dynamism and the ambiguity of the environment, resistance from different groups' modern leaders should rely on the arsenal of methods of reflexive management in their CSR management activities.

2. Brief Literature Review

The analysis of literature shows that researchers such as Lefebvre (2003, 2010), Novikov, Korepanov and Chkhartishvili (2014, 2018), Taran and Shemaev (2005), Thomas (2004), Keirr, Sherr and Seaboyer (2018), Hult, Mena, Ferrell and Ferrell (2011) have contributed to the theory and methodology of reflexive management. The results of their research are used in different fields of knowledge including economy, politics, education, military affairs, etc.

In 1960s, the forming stage of paradigm of reflexive management began. Vladimir A. Lefebvre, a mathematical psychologist, is known as the creator of the reflexive theory. He proposed

the term «reflexive control» and defined it as «a process by which one enemy transmits the reasons or bases for making decisions to another» (Lefebvre, 2003, 2010). The concepts of reflexive interaction, reflexive choice and games were represented in research works by the famous scientist. He noted that the reflexion is a certain mechanism of interaction of control system, which can act simultaneously as an object of control, that is, a controlled system, and perception of constructing the image of the object, which will depend on the action or certain reaction of the subject to this object.

In Western researches, the term «reflexive control» is often associated with the Russian information warfare principles, whereas in the Russian academic discussion it «primarily refers to «reflexive practice» in an educational or personnel management context» (Keirr, Sherr & Seaboyer, 2018).

The American management theorist T. L. Thomas emphasizes that the reflexive control theory has both military and civilian uses. He defines reflexive control «as a means of conveying to a partner or an opponent specially prepared information to incline him to voluntarily make the predetermined decision desired by the initiator of the action» (Thomas, 2004). In this case, the independent nature of the opponent's actions is foreseen, provided there is an imitation of his reasoning or behaviour, forcing him/her to accept unfavourable decision.

We propose to use the term «reflexive management» in relation to applying the reflexive theory and methodology in a management practice.

The reflexive approach as a management methodology promotes the awareness of stakeholder actions and motives to actively and purposefully impact their behaviour.

Jaitner and Kantola (2016), Heorhiadi, Shpak and Vankovych (2017) in their research consider an information manipulation to be the basis of reflexive management. Reflexive influence on the competitors and consumers is directed «towards the choice of irrational managerial decisions by the subjects which are under reflexive influence» (Heorhiadi et. al., 2017).

According to Hurievska (2014), reflexion directed to long-term consequences ensures inevitable changes, since it impacts deep structures of the personality and the management system.

Mavrina (2017) notes that reflexive influences on the subject are the basis of reflective management. Reflexive management is a form of purposeful organization of reflexive influences on the controlled subject with the purpose of inclining it to make the decisions predicted by the control system.

Schumann (2018) defines reflexive management as a «purposeful modification of some components of a controlled system for the guaranteed victory in a reflexive game». The principal kinds of reflexive management include: institutional management (modification of admissible sets of actions of all groups of agents); motivational management (modification of goal functions of concrete agents); informational management (modification of information which agents use in decision making).

Unlike decision makers, stakeholders have limited access to information on goals and strategies of business development. Mainly, the company's image formed in their mind is the basis for decisions being made about their impact on a particular entity. The notion of image in the theory of reflexive control is identical to the concept of «information model» (Lefebvre, 2003). An ability to control attitudes of the company's stakeholders, based on the reflexive management methodology, is an essential point for CSR management.

Thus, in relation to the tasks of CSR management, in previous research we proposed a definition of the reflexive management category that summarizes works of the above-mentioned researchers. Reflexive management is a conscious and purposeful formation and reconstruction of the object's image in individual and group consciousness in the desired direction via instruments of reflexive influence (Kamyshnykova, 2018).

The arsenal of reflective management is quite wide and varies depending on such factors as depth and complexity of reflexion, the number of subjects of influence, goals and directions of interaction with stakeholders, etc. The rank of reflection is one of the important factors forming the basis of reflexive stakeholder management in the CSR system. The correct choice of reflexive management instruments, depending on the rank of reflection, directly affects the effectiveness of applying the reflexive approach to managing relationships with stakeholders in the CSR system.

Despite the range of research issues in reflexive management, there is a need to further develop the methods of reflexive stakeholder management as a condition for the effective CSR management.

3. Purpose

The purpose of the research is to substantiate the use of fuzzy-logic method for diagnostics of the rank of stakeholders' reflexion and formulate types of corporate social responsibility reflexive management, depending on the reflexion rank and the level of complexity.

4. Results

The rank of reflexion is one of the basic categories of reflexive management. It means the level reflecting depth of reflexion. Several ranks of reflexion are distinguished in systems of interaction between two subjects (Figure 1).

If the subject lacks reasoning about what, how and why he does, this is called the zero rank reflexion (Figure 1, a). The subject's reflexion on his own perceptions of reality, principles of his activity is called the first rank reflexion or autoreflexion (Figure 1, b). The second rank reflexion takes place in respect to representations about realities of another entity (Figure 1, c). The subject's representations within the framework of the second-rank reflexion on the counterpart's representation about his/her own representations are characteristic of the third-rank reflexion (Figure 1, d). Theoretically, the number of possible ranks of reflexion is not limited.

The concept of rank is of great importance in theory of reflexive modelling and in reflexive games in particular. Reflexive games are defined as a class of mathematical models of games where awareness is not a common knowledge, and agents make decisions based on their hierarchy of representations (Novikov & Chkhartishvili, 2014).

The following sequence describes a reflexive game G_I:

$$G_I = \{N, (X_i)_{i\in N}, f_i(\bullet)_{i\in N}, I\} \,, \tag{1}$$

where:

N means the set of real agents, X_i is a set of accessible actions of the i-agent; $f_i(\bullet): \Omega \times X' \to R$ indicates its goal function and I is an awareness structure. Thus, a reflexive game can be interpreted as a generalized concept of the game in normal form defined by the sequence:

$$G = \{N, (X_i)_{i\in N}, f_i(\bullet)_{i\in N}\} \,, \tag{2}$$
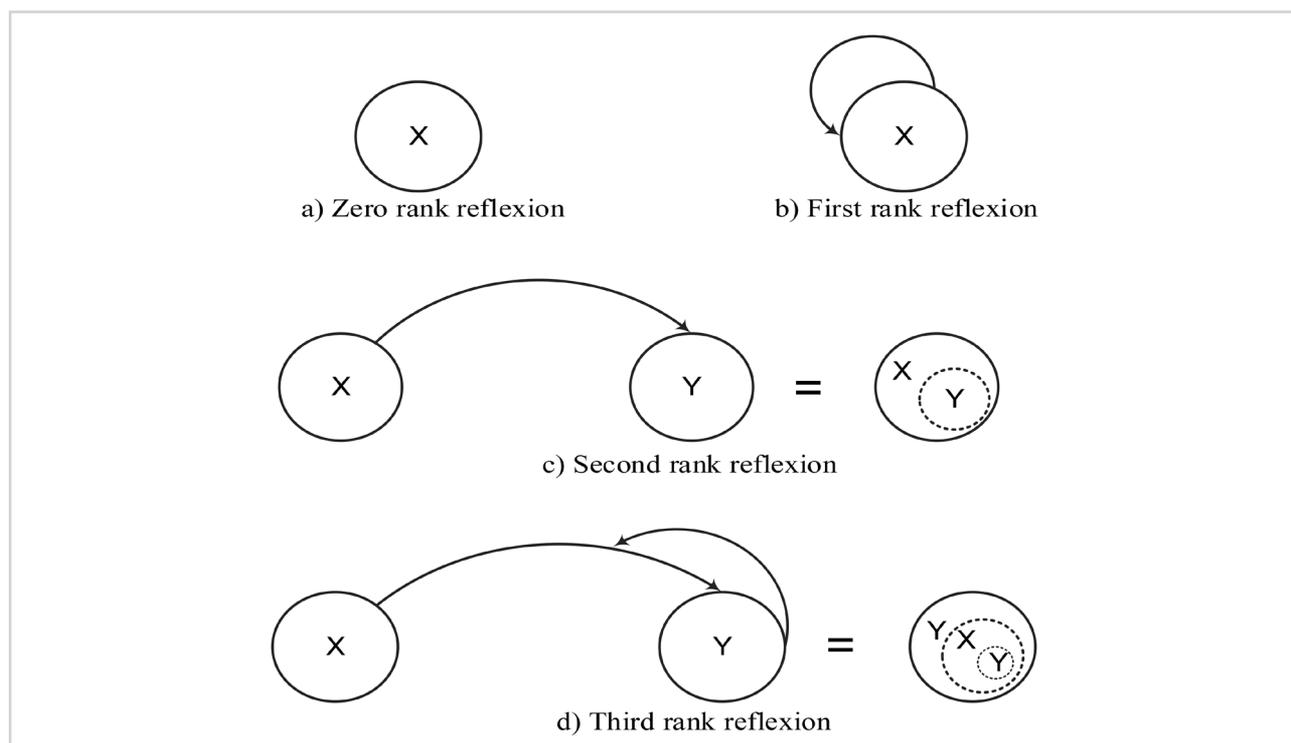
Figure 1:
Ranks of reflexion
Source: Compiled by the authors based on works by Lefebvre (2003, 2010),
Novikov and Chkhartishvili (2014)

in the case when the agents' awareness is reflected in hierarchy of their representations (information structure I) (Novikov & Chkhartishvili, 2014).

As shown in Lefebvre (2003), in reflexive games the advantage is got by the agent, whose rank of reflexion is one step higher than the opponent's one. If the first agent's rank of reflexion is more than one step higher than that of the opponent's, it can cause the situation «tricked by oneself», giving advantages to the low-ranking agent. Thus, correct information about the rank of the opponent's reflexion is one of the most important conditions for effective application of reflexive management.

Despite the importance of this issue, only a partial theoretical study has been performed to date. The rank of reflexion is considered as an important component of cognitive models of reflexive management proposed in the research of Taran and Shemaev (2005). However, the authors do not give recommendations for determining this parameter.

Schumann (2014) states that the reflexive level n can be any natural number. He proposes usage of the reflexion disagreement theorem to «formalize reflexive games of different reflexive levels (up to the infinite reflexive level)» (Schumann, 2014).

Novikov and Chkhartishvili (2014) justify limitations of the maximum reasonable rank of reflexion. In particular, it is shown that for a regular awareness structure of agents of reflexive interaction (that is, if there is a periodic repetition of optimal actions with an increase in the rank of reflexion) for a game with two agents, the maximum advisable subjective rank of information reflexion is $k = 2$. If the awareness structure is irregular, a priori the maximum suitable rank of reflexion cannot be limited (Novikov & Chkhartishvili, 2014).

Most authors, considering various aspects of reflexive management from theoretical point of view, research only ideal variants. In particular, the passive agent is seen as a monolithic subject with a certain rank of reflexion. In practice, however, economic entities are systems, and therefore they are endowed with all relevant properties: complex structure, dynamism, adaptability, and so on.

An analysis of the long-term use of reflexive management possibilities in the company's relations with stakeholders in the context of the ranks of reflexion from the point of view of the system approach allows us to formulate the following conclusions:

B1

The rank of stakeholder's reflexion can change over time (*dynamic* property). So, if the passive agent of reflexive interaction realizes that he is being manipulated, he changes his behaviour. That is, in the general case:

$$_n k_t \neq {_n k_{t+1}} , \tag{3}$$

where:

$_n k_t$ is the rank of the agent n reflexion in the time period t.

Let us assume that a game G_I begins with the time step $t = 0$ and stops at the time step $t = m$, i.e. it has $m + 1$ steps. At each step, each player can have a different rank of reflexion from 0 to a natural number 1, 2, 3, ... Hence, through the whole game we deal with the following sequence for each player n: $_n k_0 \, _n k_1 \, ... \, _n k_m$. This sequence is called the rank of the agent n reflexion during the whole game. For each $i = 0, ..., m$ and each player n, $_n k_i$ is equal to an integer k_i that is the rank of n at i. So, $_n k_0 \, _n k_1 \, ... \, _n k_m = (k_0 \, k_{1 \, ...} \, k_m)$.

Let $p - 1$ be the highest rank for all the players at all time steps. Then all the ranks of all the players during the whole game can be understood as p-adic integers of the following form:

$$(k_0 \, k_{1 \, ...} \, k_m) = \sum_{i=0}^{m} k_i \cdot p^i . \tag{4}$$

Let us consider an example of a reflexive game with the players n_1 and n_2 and the three time steps $t = 0, 1, 2$. Let us assume that 2 is the maximal rank at all time steps for both players. It means that we deal with 3-adic integers. Now, let us suppose that:

$$_{n1} k_0 \, _{n1} k_1 \, _{n1} k_2 = (121),$$

$$_{n2} k_0 \, _{n2} k_1 \, _{n2} k_2 = (022).$$

It means that:

$(121) = 1 \cdot 3^0 + 2 \cdot 3^1 + 1 \cdot 3^2 = 16,$

$(022) = 0 \cdot 3^0 + 2 \cdot 3^1 + 2 \cdot 3^2 = 24 .$

This shows that the p-adic representation of ranks during the whole game allows us to order linearly the ranks. In such a way, $_{n1}k_0 \, _{n1}k_1 \, _{n1}k_2 < \, _{n2}k_0 \, _{n2}k_1 \, _{n2}k_2$, because 16 < 24.

B2

The rank of the stakeholder's reflexion may vary depending on the «rates», i.e. estimated incurred costs in each specific case (the property of *adaptability*). Therefore, if the rates are relatively low, the stakeholder can remain at the zero-rank of reflexion, even realizing that he/she can be manipulated. If high costs are assumed, we should expect a more thorough analysis of information by the stakeholder. This assumption can be formalized as follows. Let g be a function from N to N. It takes the value of 0 if and only if the rates are relatively low. It takes the value $n + 1$ if and only if the rates and high and the reflective rank of competitors is evaluated as n. Let us suppose that the players n_1 and n_2 have the costs $_{n1}C_0 \, _{n1}C_1 ... \, _{n1}C_m$ and $_{n2}C_0 \, _{n2}C_1 ... \, _{n2}C_m$ respectively through the whole game with $m + 1$ steps. Then:

$g(_{n1}C_0) g(_{n1}C_1)) \, ... \, g(_{n1}C_m) = \, _{n1}k_0 \, _{n1}k_1 \, \cdots \, _{n1}k_m ,$

$g(_{n2}C_0) g(_{n2}C_1)) \, ... \, g(_{n2}C_m) = \, _{n2}k_0 \, _{n2}k_1 \, \cdots \, _{n2}k_m .$

In other words, the costs $_{n1}C_0 \, _{n1}C_1 ... \, _{n1}C_m$ and $_{n2}C_0 \, _{n2}C_1 ... \, _{n2}C_m$ and the function g allow us to define the ranks of reflexion $_{n1}k_0 \, _{n1}k_1 \, \cdots \, _{n1}k_m$ and $_{n2}k_0 \, _{n2}k_1 \, \cdots \, _{n2}k_m$.

B3

The stakeholder's reaction to reflexive influence may not conform unambiguously to any particular rank of reflexion.

Now let us notice that the zero-rank reflexion of the agent n corresponds to a set of accessible actions $X_n^0 = \{x_{1n}^0, x_{2n}^0, ..., x_{jn}^0\}$, the first rank of n to $X_n^1 = \{x_{1n}^1, x_{2n}^1, ..., x_{jn}^1\}$, and the k rank of n to $X_n^k = \{x_{1n}^k, x_{2n}^k, ..., x_{jn}^k\}$. Since in practice these actions are in the field of reactions to many agents, making decisions independently to some extent (*structure* property), the actual set of the stakeholder n reaction can be presented as following:

$$X_n = \{x_{1n}^0, x_{2n}^0, ..., x_{jn}^0, x_{1n}^1, x_{2n}^1, ..., x_{jn}^1, ..., x_{1n}^k, x_{2n}^k, ..., x_{jn}^k\}.$$

That is, it contains separate actions that correspond to the zero, first and, presumably, the k rank of reflexion.

Let us suppose that the players n_1 and n_2 have the ranks $_{n1}k_0 \, _{n1}k_1 \, \cdots \, _{n1}k_m$ and $_{n2}k_0 \, _{n2}k_1 \, \cdots \, _{n2}k_m$, respectively, through the whole game with $m + 1$ steps. Then, we have the following vectors of accessible actions for both players:

$x_{n_1 1}^{k_0} x_{n_1 2}^{k_1} ... x_{n_1 m}^{k_m}$

$x_{n_2 1}^{k_0} x_{n_2 2}^{k_1} ... x_{n_2 m}^{k_m} .$

Thus, in practical application of reflexive management methods in economic interactions, the ambiguity and variability of the rank of the stakeholder's reflexion should be taken into account.

Since the company's relations with stakeholders are of a long-term nature, the methods of forming reflexive influences should be oriented toward obtaining high effect in the long run, rather than on separate management activities. This approach limits the ability to use existing reflexive management apparatus (as already noted, it is focused mainly on one-time influences). However,

on the other hand, the same circumstances allow the company to apply statistical methods of analysis. In other words, occasional setbacks are permitted, if, in the end, the company receives a positive effect.

Fuzzy logic diagnostic method of the rank of stakeholders' reflexion

In the process of reflexive interactions, the company accumulates a certain database on the stakeholder's reactions to impacts. Given the ambiguity of knowledge of an active agent and the ambiguity of the reactions of a passive agent, it is advisable to form this base in a fuzzy set, and use the fuzzy logic apparatus for transactions with it.

Before formulating the problem of determining the rank of the stakeholder's reflexion in a fuzzy form, we should consider the basic concepts and principles of fuzzy logic.

Fuzzy logic is used in conditions of incomplete or diffused information about the object under consideration. Fuzzy description of the subject area is much closer to a natural language and a way of thinking than to a description in terms of formal logic. Hence, such relationships as «possible», «probably not», «sometimes» and the like can be written down and used for derivation by means of fuzzy logic. This tool makes it possible to describe the subject area and content of knowledge bases.

The mathematical apparatus of fuzzy logic allows both to describe such elements, and to perform operations equivalent to those in classical logic and to interpret results from a practical point of view. The statement that the degree of an element's membership to a certain set can take values from the closed interval [0, 1] is the basis of fuzzy logic. In this case, any object can simultaneously belong to several sets. So, a person at the age of 35 can be perceived by other people as both «young» and «middle-aged». This cannot be described by classical logic methods, but it is easily described in terms of fuzzy logic.

Methods of fuzzy logic are effective in tasks of making multi-criteria decisions, processing the opinions of a group of experts.

Development of any system by using the fuzzy logic apparatus includes at least three mandatory procedures:

1. Fuzzification, which means the definition of fuzzy sets and the rules for translating raw data into fuzzy ones (including the definition of linguistic variables and membership functions).
2. Solution of a problem in fuzzy terms, which is the creation of rules for data processing.
3. Defuzzification, which is the definition of rules for translating the results of decisions into clear values that can be used in further procedures.

It is advisable to consider the concept of fuzzy set.

Let x be an element of the universal set E, and W be some property. An average clear subset A of the E set, which elements satisfy the property W, can be defined as a set of ordered pairs $(\mu_A(x),x)$, where $\mu_A(x)$ is the characteristic function taking the value 1 if x of E satisfies the property W, and 0 otherwise.

To simplify the recording of clear sets, only those elements for which $\mu_A(x) = 1$ are usually shown.

A fuzzy subset differs from the common one. It is impossible to give an unambiguous answer to the question: «Does the element satisfies property W, or not?» for elements x of E, however one can give an estimate (probabilistic, statistical, expert, etc.) of the element's correspondence degree to this property. The estimation $\mu_A(x)$ is called the characteristic membership function, or simply the membership function.

Depending on whether the set of fuzzy values is continuous or discrete, either direct or group methods of defining membership function can be used.

Let X_n^k be an accessible action from X_n for the agent n. Since the rank of reflexion k is a discrete element, it will be specified by the function h as follows:

$$h(x_n^k) = \{(\mu_{x_n^k}(0), 0), (\mu_{x_n^k}(1), 1), ..., (\mu_{x_n^k}(k), k)\}$$

(5)

$$\mu_{x_n^k}(k) \in [0, 1] \ .$$

Consequently, $\mu_{x_n^k}(0)$ corresponds to our membership assessment of the stakeholder's reflexion to the zero rank; $\mu_{x_n^k}(1)$ and $\mu_{x_n^k}(k)$ meet the first and the k rank, respectively. If it is necessary to consider the higher levels of reflexion, a fuzzy set can be extended by appropriate elements.

Let us examine calculation methods for $\mu_{x_n^k}(k)$.

Let us measure the results of reflexive influence of n by using the i time steps corresponding to the assessment of stakeholder's individual actions in the context of his/her rank reflexion:

$$x_{n1}^{k_0} x_{n2}^{k_1} \dots x_{ni}^{k_i}.$$

Then,

$$\mu_{x_{n(i+1)}^{k_{i+1}}}(k) = \frac{\sum_i \langle k_i == k \rangle}{i}, \tag{6}$$

where:

$\langle k_i == k \rangle$ the expression represents the comparison operation, with the result presented in terms of Boolean algebra:

$$\langle k_i == k \rangle := \begin{cases} 1; k_i = k \\ 0; k_i \neq k \end{cases}. \tag{7}$$

Let us consider an example.

Suppose, as a result of evaluating the stakeholder's reaction on the reflexive influence, a set X, consisting of five estimates, is obtained:

(10112).

Hence, we can calculate $\mu_{x_{n6}^{k_6}}(k)$ for $k = 0, 1, 2$:

$$\mu_{x_{n6}^{k_6}}(0) = \frac{1}{5} = 0.2;$$

$$\mu_{x_{n6}^{k_6}}(1) = \frac{3}{5} = 0.6;$$

$$\mu_{x_{n6}^{k_6}}(2) = \frac{1}{5} = 0.2.$$

Thus, a fuzzy assessment of the rank of the stakeholder's reflexion from the results of this influence will be written as:

$$h(x_{n6}^{k_6}) = \{(0.2, 0), (0.6, 1), (0.2, 2)\}. \tag{8}$$

Let us consider the maximal level of reflexion k_{max} and the minimal level of the reflexion k_{min} for all actions of n from 0 to i. Let be $\frac{k_{max} + k_{min}}{2}$. Then we can define a probability function for an action at $t = i + 1$:

$$P^{\bar{k}}(x_{n(i+1)}^{k_{i+1}}) = \frac{\mu_{x_{n(i+1)}^{k_{i+1}}}(k_{max}) + \mu_{x_{n(i+1)}^{k_{i+1}}}(k_{min})}{2}. \tag{9}$$

In our example:

$$P^1(x_{n6}^{k_6}) = \frac{\mu_{x_{n6}^{k_6}}(k_{max}) + \mu_{x_{n6}^{k_6}}(k_{min})}{2} = \frac{0.6 + 0.2}{2} = 0.3.$$

This probability is called the probability of overage reflexion rank at $t = i + 1$.

Since the same mathematical actions, including finding the average, determining trends, constructing forecasts can be performed both with fuzzy and conventional numbers, the base of such assessment will significantly reduce uncertainty regarding the rank of the stakeholder's reflexion.

After all analytical procedures, the result can be converted to an ordinary number, by the above-mentioned defuzzification procedure. So, the crisp number 1 will correspond to the fuzzy number from the expression (8). That is, the most probable rank of stakeholder's reflexion in this case is rank «1», and the other estimates may be a consequence of measurement errors or interpretation.

Thus, the storage of the stakeholder's reaction estimates as fuzzy sets allows considering the conclusion of B3 and giving opportunities for further analysis of patterns changing the stakeholder's rank of reflexion within the conclusions B1 and B2.

The practical application of the described fuzzy method for diagnostics of the rank of stakeholders' reflexion is possible in all areas where reflective management is used, consciously or unconsciously. We can mention political, social, commercial, and market relations. The common thing for them is that in addition to the direct «mathematical» result, it is necessary to pay attention to the «image» result, which actually creates the prerequisites for the reflexive management through the influence of the «image» component on the subjective assessment.

In addition, the following conditions must be met:
- the ability to track the feedback (due to the need for a fairly accurate study of the reaction to control actions);
- inertia of the processes (patterns of results should be relevant for some time after their discovery);
- the possibility of obtaining a sufficient number of observations for the model to work.

Thus, if we consider only managed entities that are connected with the managing entity by commercial relations, the scope of the proposed methods will be limited to the markets of various financial instruments, as well as the bulk commodities' markets with a high level of competition. The foreign exchange market («Forex»), considered from the perspective of reflexive management, is a typical example of relations with a constantly changing rank of reflection. The ability to determine the actual value of this rank determines success in the market largely.

The consumer electronics market is a striking example of the second type, where Apple Inc. has been an unrivalled master of reflexive management for many years.

If we consider all stakeholders as managed entities, then the scope of the described methods will expand significantly.

It includes large enterprises with a large number of employees, so we can carry out the diagnostics of the rank of reflexion to determine the optimal motivation system for them. State and public organizations can also be attributed to this area, where the diagnostics of the rank of reflexion will improve the process of planning social development.

Types of CSR reflexive management

The rank of reflexion affects the CSR level and extent, taken by the company's management. This makes the latest more inclusive with respect to stakeholders' interests.

An increased reflexion rank involves the increasing depth and complexity of the reflexive influences' application to various stakeholder groups on the basis of information about their objectives, interests and capabilities. This leads to growing interaction efficiency between the company and stakeholder and results in an increase of the CSR level.

Different levels of responsibility are considered as stages of CSR management and sustainable development. During the promotion through the stages, companies usually stop considering socio-environmental issues as an obstacle to business, become more sensitive to stakeholder interests and increasingly strive to address the challenges of sustainable development (Maon, Lindgreen, & Swaen, 2010).

Zadek (2004) examines five stages of organizational learning of the company that it takes in developing CSR: protective, collaborative, managerial, strategic and civil stages. As well as Caroll (1979), Zadek (2004) [30] believes that each firm must pass these five stages in order to achieve a civil model. We propose to put the specified models in correspondence with the types of CSR reflexive management, which vary depending on the level of management responsibility to stakeholder groups, determined by rank of reflexion.

The transition to each subsequent level of CSR development is associated with the increased company's rank of reflexion in relation to interests of different stakeholder groups. Thus, we propose to consider the types of CSR reflexive management, depending on the rank and the complexity level of reflexion, which adheres to the company's management (Table 1).

The table shows that the zero rank of reflexion corresponds to the non-reflexive, defensive type of CSR management. The use of this kind of CSR management is inefficient and somewhat «exotic» in the current market conditions. It provides a complete rejection of critical perception of management's own actions and decisions that jeopardize prospects for the company's existence and development.

Table 1:
**Dependence of the type of CSR reflexive management on the rank
and the complexity level of reflexion**

Type of CSR reflexive management	Rank / Complexity level of reflexion	Characteristic
Defensive	Zero	Facing the problems caused by a mismatch between the company's image and reality, the management takes a defensive position in relation to the subjects criticizing its actions, reflects attacks on reputation in the short term and refuses to be socially responsible.
Compliance	First	The company's management implements socially responsible measures taking into account stakeholder interests and wishes in minimally necessary boundaries, in pursuit of the objective of reducing economic losses and risks through a stable reputation.
Managerial	Second / Integrating CSR practices at the operational level of management	The management implements socially responsible business practices in key management processes at the operational level, which contributes to an economic viability.
Strategic	Second / Integrating CSR practices into key business strategies	The content of management is to coordinate the strategy and process of innovation with social requests, which leads to increased competitive advantages and contributes to a long-term success.
Civil	Second / Integrating CSR practices in industry level	The company recognizes the importance of leadership in CSR and encourages other industry firms to collaborate in a socially responsible area. Such actions are related to the allocation of competitors as a strategic category of stakeholders.

Source: Compiled by the authors

The first rank of reflexion, identified with the autoreflexion, describes the initial type of reflexive CSR management. The use of first-rank reflexion leads to awareness of interests and goals of stakeholder groups that influence the company's development by their actions and decisions. This translates relations with relevant stakeholder groups into coordination mode and corresponds to a compliance type of reflexive CSR management.

Realizing the importance of competent intervention in the construction of company's image in the stakeholder eyes, the management actually implements the second rank reflexion and transfers the reflexive management into a qualitatively new managerial level.

Given the existence of restrictions to the most appropriate rank of reflexion, we consider that more complex types of reflexive CSR management (strategic and civil) do not require further rank improvement and correspond to second-rank reflexive effects.

Expanding the scope and complexity of implementing reflexive management integrates socially responsible activities into key business strategies, forming the strategic type of reflexive CSR management.

The further integration of socially responsible practices in the industrial format ensures the formation of the civil stage of CSR. The achievement of the civil type of reflexive CSR management characterizes the highest stage of implementation of reflexive management tools. It's a complex methodological and practical task.

Reflexive stakeholder management is aimed at developing reflexive influences on the groups of interested parties and their representatives, thereby increasing the efficiency of interaction with them in the CSR framework.

The selection and use of relevant reflexive influences as CSR implementation tools provides a balance of interests between the company and stakeholders and allows achieving goals in the most optimal way.

5. Conclusions

The need to effectively manage relationships with stakeholders is crucial in a CSR system. Traditional methods of stakeholder management do not take into account psychological aspects of economic processes and they cannot be successful in all cases. The introduction of reflexive management methods into the CSR practice forms the basis to improve management effectiveness.

Reliable awareness of the rank of stakeholders' reflexion is one of the most important conditions for the effective use of reflexive management in the CSR system. In most theoretical studies in the field of reflexive management, perfect cases are considered, when the subject of reflexive interaction has a specific rank. Unlike the existing apparatus of reflexive games, which takes into account mostly one-time effects, the use of the fuzzy-logic method for diagnosing the rank of stakeholders' reflexion in a CSR system is suggested. This allows considering the ambiguity and variability of the rank of stakeholders' reflexion in practical application of reflexive management

methods in the long run and corresponds to the system's properties of dynamism (B1), adaptability (B2) and structure (B3).

The rank of reflexion affects the CSR level and extent, taken by the company's management. The increased rank of reflexion provides increasing depth and complexity of the reflexive stakeholder influences and results in the boosting CSR level. Regarding this, it is proposed to consider the types of CSR reflexive management, depending on the rank and complexity level of reflexion, used by the company's management. The following types of CSR reflexive management are identified: defensive, compliance, managerial, strategic, and civil.

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