The Prediction of Successful Probability of CSR and Sustainable Development Strategy Implementation within "Roşia Montană Project" using Fuzzy Logic

Lucian SÎRB
West University, Timişoara, Romania
luciansirb86@yahoo.com

This article aims to develop a methodology to forecast the probability of success regarding to the implementation of the concept of corporate social responsibility (CSR) and of the strategy of sustainable development in a mining company of exploitation of mineral resources. It is well known that in the modern period we are witnessing ever more to increased demands in terms of corporate responsibility towards the environment, in the area which can include economic, social, cultural and ecological environment. As a consequence of this fact, it increases the uncertainty of decisions to be adopted by companies, uncertainty that may arise from several aspects such as incompleteness, inconsistencies or inaccuracies in information or simply due to the subjective nature of human reasoning which often is expressed in words, through linguistic values. Thus, for modeling this vagueness of decision or prediction process there is a particularly effective tool, represented by the fuzzy logic through triangular fuzzy numbers. By multiplying the importance weight of factors that influencing the adoption of CSR and sustainable development policy with values resulting from evaluation of the possibility of successful implementation of this policy with respect to each factor, there it results a probability that suggests us if the action of implementation of CSR and of sustainable development strategy will have the overall expected effect and in the case the result is not properly there it will require remedial measures. The proposed methodology is applied in a case study concerning the Romanian mining company Roşia Montană Gold Corporation (RMGC) from Roşia Montană, Romania and also concerning the community in which it operates.
Keywords: *CSR, Sustainable Development, Fuzzy Logic, Prediction*

1 Introduction

For any company, the sustainable development must be more than a series of corporate commitments and promises. The development of tools for measuring progress – to ensure consistency between promise and performance – is the real test of a responsible behavior in social terms. CSR is defined as a "voluntary corporate commitment exceeding the explicit and implicit obligations imposed on a company by society expectations in terms of conventional corporate behavior" [1]. There are intense discussions on the extent to which corporate social responsibility should be a central concept: if it is really essential for the way the company operates or if it's just a concession made because of external pressures from stakeholders and critics. With regard to the mining company to which we refer in this article, as an aside, it is well known that in most of Eastern Europe and in Romania including there were conducted mining activities over time without taking into account the long term benefits for community and for country in general, that's why one of the Roşia Montană Gold Corporation's (RMGC) strategic objectives is that its commitment for sustainable development to be essential for achieving "social license" and success.

For corporations, generally, the adoption of CSR strategies can improve their relationships with different stakeholders. Therefore, is required the public notice regarding to CSR activities and use of an effective management of relations with all actors involved in company's life to meet their expectations and achieving the strategic objectives of CSR initiatives [2]. It is well

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known that proper implementation of some CSR practices in particular and of sustainable development generally is no small challenge for any company in any industry. That's why, the activity of forecasting the success or failure resulting from the implementation of CSR and of sustainable development policy, should be a key objective of any business strategy, to know exactly which will be the future results and if eventually there is a particular need to adjust the tactical and operational processes. The challenge is even greater for a company in the mining industry sector, which is operating in a region designated by the government until three years ago as deprived area, company that is the only one that offers economic opportunities, within an environment of uncertainty and risk and which raises the issue of subjectivity of human decision factor reasoning, aspect modeled in this paper by the technique of fuzzy logic and of fuzzy multicriteria decision, which is an effective tool for prediction regarding to adoption of a plan or another of CSR and which allows to address remarks for improving on what does not meet the performance requirements.

By that time, there are a lot of studies in the international literature with references to practices and communications of CSR across several industries (ex. [3], [4]). The socio-economic impact of extractive industry is significantly, that is why the benefits generated should provide a sustainable economic welfare at all levels through the implementation of the responsibility among of authorities, providers, contractors, employees and through the insurance of an equitable and fair distribution of all economical, social or ecological benefits.

As a novelty in this field of CSR, this article addresses not a top-down strategy, but a bottom-up one, thereby encouraging the contributions to community development and the implementation of an performance policy of corporate social responsibility, to meet the expectations regarding to the success of its lines of action.

2 Literature Review

Worldwide there are a number of frameworks and regulations with regard to internationally recognized standards of conduct in the implementation of CSR and sustainable development policy, at which RMGC Company has joined, among which are found the following: [5], [6], [7], [8], [9], [10], [11], [12], [13]. Also, within RMGC company it is trying continuously to obtain a feedback on sustainable development strategy by hiring outside experts and consultants and by inviting auditors to measure the performance in relation to the [14] and the best international applicable practices.

To predict the success or failure in the implementation of certain directions of action within the company's corporate responsibility and sustainable development strategies, the most specialists are using methods based on classical mathematics and on conventional statistics and probabilities ([15], [16]), which are limited in modeling the uncertainty and the vagueness present in the real world and do not take into account the subjectivity of human reasoning. Therefore, the fuzzy logic through the fuzzy multicriteria decision is an effective tool in predicting the results from adoption of a CSR plan or of another and allows to address remarks for improving on what does not meet the performance requirements.

It is completely wrong and unrealistic to assign a fixed value to a subjective judgment, especially when the information is vague or imprecise. Therefore, this paper introduces the fuzzy concept for dealing easily and effectively on uncertainty and vagueness from the real world. [17, 18] is considered the father of fuzzy logic, which otherwise proposes the fuzzy sets theory as a practical tool for modeling the subjectivity of decision making process. Thus, starting with [19] and continuing with [20], many decision makers have adopted the fuzzy sets theory in vagueness environments and situations to deal with the uncertainty and subjectivity.

In the following, I will mention some recent researchers together with their applications

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related to the fuzzy logic tool. For example, [21] have used the fuzzy multicriteria decision model for evaluating of investments in IT/IS and [22] for the selection of human capital resources in a private Greek bank. [23] proposed a fuzzy multiatribut decision making model within a group for the selection of air conditioning system type that should be installed in a library, while through using fuzzy logic with related fuzzy sets, [24] measured the uncertainty in the political activities of voting, while [25] assessed the financial performance of domestic airlines in Taiwan.

After browsing literature, the process of fuzzy multicriteria decision making (FMCDM) was often adopted as a tool for selection, evaluation and ranking and rarely in prognosis or prediction problems. Therefore, this article is a challenge because of its purpose in finding out the likelihood of successful implementation of CSR and sustainable development policies within a mining company and eventually in the case of an undesirable result the readjustment or shift of these policies. In literature there are several researches related to the prediction technique using fuzzy logic. For example, [26] use a fuzzy prediction architecture using the recurrent neural networks, while [27] are using fuzzy rules for predicting the demand for newspapers. Also, [28] use the support of fuzzy logic for predicting the companies' bankruptcy or insolvency, [29] have developed a fuzzy predicted system for measuring the performance, [30] developed a neuro fuzzy adaptive system of inference to predict the water levels in reservoirs, while [31] propose a fuzzy prediction methodology in terms of Earth rotation parameters.

3 The Proposed Methodology

As I mentioned until now, for predicting the possibility of successful implementation of CSR and sustainable development policy, there is a very effective tool in terms of modeling the uncertainty and vagueness of the decision-making environment and the subjectivity of human decision-making factor namely the theory of fuzzy logic and default the fuzzy multicriteria decision making method. It should be noted that this method focuses on modeling the linguistic values, which otherwise is representing the subjective opinion of decision makers, expressed in words or linguistic expressions and incorporated into decision-making process through the triangular fuzzy numbers. In the following, I will elaborate more specifically the way of methodology implementation.

3.1 The Theory of Fuzzy Numbers

The fuzzy sets theory has been developed since the 60's, as a response to the insufficient consistency of the deterministic reasoning type like "yes" or "not", trying to formalize some reasons such as "more or less". In classical logic, the propositions can be true or false, without the possibility of intermediate values. In the case of the approach of concrete models, from the real world, it was found the appearance of delicate situations: not all real systems are clear and deterministic, so that they cannot be described exactly through the classical logic and the complete description of a real system requires a series of information which are not known or fully provided and often are not understood exactly. Thus, it appears necessary to use fuzzy sets and the fuzzy logic resulted from their uses, instead of classical, crisp sets.

The fuzzy sets theory was developed by [17, 18], who observed that the classical mathematical models and different methods in grounding decision-making process have imperfections and are difficult to apply to the complex reality of economic factors. As the complexity of an economic process increases it can be arrived at a critical point, from which the precision and significance of statements about the behavior of the process are incompatible. The incompatibility principle defined by [17] converges to vague (fuzzy) statements and the fuzzy logic is trying to create a formalism for the uncertainty and ambiguity which is specific to natural language, which has the purpose to model it.

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Let X a collection of objects denoted generically by x. A fuzzy set A over the set X is defined by a set of ordered pairs of the form:

$$A = \{(x, \mu_A(x)) / x \in X\} \qquad (1)$$

where $\mu_A(x)$ is called the membership function of fuzzy set A.

The construction of a fuzzy set depends on establishing the universe of discourse and of the membership function. The choice of membership function is subjective, in the sense that various people can choose different membership functions to express the same concept. This subjective bias arises from the differences among individuals relatively to how they perceive and express abstract concepts.

A fuzzy number A is a fuzzy set which has as universe of discourse the real numbers axes and which satisfies the conditions of normality and convexity, set out below:

1) the fuzzy set A is normal if its core is a non-empty set (there is at least one element $x \in A$ so that $\mu_A(x) = 1$).

$$\text{core(A)} = \{x \in X / \mu_A(x) = 1\} \quad (2)$$

The core of a fuzzy set A is given by the set of elements $x \in A$ for which $\mu_A(x) = 1$.

2) The fuzzy set A is convex if and only if for any $x_1, x_2 \in X$ and any $\lambda \in [0,1]$, occurs the following relationship:

$$\mu_A(\lambda \cdot x_1 + (1-\lambda) \cdot x_2) \geq \min\{\mu_A(x_1), \mu_A(x_2)\} \quad (3)$$

In theory there are two types of fuzzy numbers, triangular and trapezoidal, but in the following we will work with triangular fuzzy numbers. A triangular fuzzy number denoted by $A = (a_1, a_2, a_3)$ can be graphically represented as in figure 1, where practically it is noted that it is framed by three values, respectively a_1, which is the smallest and represent the lower border of number, a_2 which practically represents the maximum of membership function - $\mu_A(x) = 1$ and a_3 which is the upper boundary of the number.

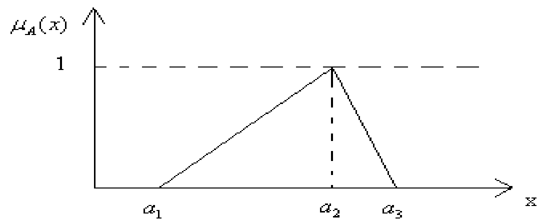

Fig. 1. The representation of the triangular fuzzy number $A = (a_1, a_2, a_3)$

According to the [18]'s principles and researches (1999), in case that we have two triangular fuzzy numbers $A = (a_1, a_2, a_3)$ and $B = (b_1, b_2, b_3)$, between them may exist the following operations:

- addition: $(a_1, b_1, c_1) + (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$; (4)
- decrease: $(a_1, b_1, c_1) - (a_2, b_2, c_2) = (a_1 - a_2, b_1 - b_2, c_1 - c_2)$; (5)
- multiplication: $(a_1, b_1, c_1) * (a_2, b_2, c_2) = (a_1 * a_2, b_1 * b_2, c_1 * c_2)$; (6)
- division: $(a_1, b_1, c_1) / (a_2, b_2, c_2) = (a_1 / a_2, b_1 / b_2, c_1 / c_2)$; (7)
- inversion: $(a_1, b_1, c_1)^{-1} = \left(\frac{1}{a_1}, \frac{1}{b_1}, \frac{1}{c_1}\right)$; (8)
- multiplication by a real number α : $\alpha * (a_1, b_1, c_1) = (\alpha a_{1,} \alpha b_1, \alpha c_1)$. (9)

3.2 Establishing of Linguistic Values and Their Related Fuzzy Numbers

The goal itself of fuzzy numbers is for modeling the linguistic variables, respectively that linguistic values associated with the subjective human reasoning. Therefore, it is known that people's opinions are often expressed in an ambiguous, vague

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way or language, by linguistic expressions or words, which is harder to quantify them by classical logic, that's why using the fuzzy numbers and their membership function, which can take values between 0 and 1, these linguistic values can be modeled in an effective and comprehensive way.
Strictly on our example namely that the predictive one in what it means the probability of success or failure of implementation of certain directions in terms of CSR and sustainable development policy, we face two types of linguistic variables, schematically represented in figures 2 and 3, as follows:
1) the linguistic variable defining the importance weight of factors followed in the implementation of CSR and sustainable development policies;

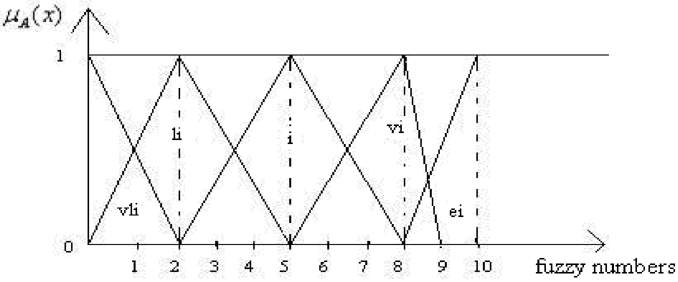

Fig. 2. The linguistic evaluation of the importance weight of factors by fuzzy triangular numbers

2) the linguistic variable expressing the assessment of the successful implementation of CSR and sustainable development policy with respect to each factor initially set;

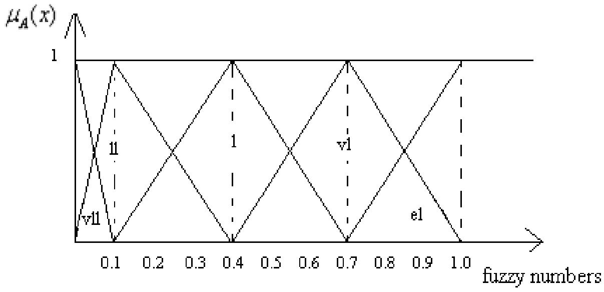

Fig. 3. The linguistic evaluation of the possibility of CSR and sustainable development policies successful implementation with respect to each factor

Further details for the values of the linguistic variables mentioned before associated with their corresponding triangular fuzzy numbers which incorporates them from expressing an opinion through linguistic expressions by the subjective human decision factor are presented in tables 1 and 2.

Table 1. The linguistic values with their corresponding triangular fuzzy numbers related to the importance weight of factors

Linguistic value	Corresponding triangular fuzzy number
Very little important (vli)	(0,0,2)
Less important (li)	(0,2,5)
Important (i)	(2,5,8)
Very important (vi)	(5,8,9)
Extremely important (ei)	(8,10,10)

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It should be noted that in terms of determining fuzzy numbers (falling on a scale of 1 to 10), for assessing the importance weight of factors, this job was done through a committee consisting of four members of the superior management team, respectively The Executive Director (D_1), The Senior Vice President Government Affairs and Community Relations (D_2), The Vice President Patrimony and Sustainable Development (D_3) and The Vice President Environment (D_4).

Regarding to the establishment of fuzzy numbers that's incorporating the assessment of the possibility of successful implementation of CSR and sustainable development policy with respect to each factor initially set, these fall on a scale of values in the range $[0.0,1.0]$, reflecting so the real expression in percentage of this successful possibility. It should be noted that this assessment will still be done by the superior management team as shows in previous organization chart, mainly due to their hierarchical position and experience in the company.

Table 2. The linguistic values with their related triangular fuzzy numbers for the evaluation of successful possibility of CSR and sustainable development policy implementation with respect to each factor initially set

Linguistic value	Corresponding triangular fuzzy number
Very little likely (vll)	(0.0,0.0,0.1)
Little likely (ll)	(0.0,0.1,0.4)
Likely (l)	(0.1,0.4,0.7)
Very likely (vl)	(0.4,0.7,1.0)
Extremely likely (el)	(0.7,1.0,1.0)

3.3 The Identification of Factors Used in Evaluating the Successful Implementation of CSR and Sustainable Development Plan and the Design Methodology

In the moment that [5] standard was completed and published in 2010, which was developed by over 400 experts from 87 countries, as well as by many experts from world-class organizations, such as the European Commission, the World Health Organization, the United Nations Development Programme, International Amnestz and various trade unions and employers organizations, it detailed a series of principles for Social Responsibility that affecting certain key issues, such as human rights, environmental protection, labor market, consumers protection or the good practices of operation and community involvement.

Regarding the adoption of this standard ([5]) by the RMGC mining company, standard which otherwise provides important lessons in the implementation of CSR principles and programs, it should be noted that RMGC are among the first Romanian companies involved with the Standards Association from Romania into the program adoption of [5] standards within its policies, corporate programs and practices.

Therefore, to achieve success in implementing such a policy of CSR is a prerequisite for the advancement of the mining project and for achieving of the so-called "social license". More so, to achieve this goal in an effective and performing way, this research aims to develop a consistent methodology, for anticipate or foresee the possibility of success of the lines of action regarding to the implementation of CSR and sustainable development plan, methodology which otherwise is summarized in figure 5.

After summarizing the standards content of conduct internationally recognized in the implementation of CSR and sustainable development that RMGC company embraced them, the management team concluded that the factors shown in table 3 are primarily in terms of drawing a consistent CSR and sustainable development strategy.

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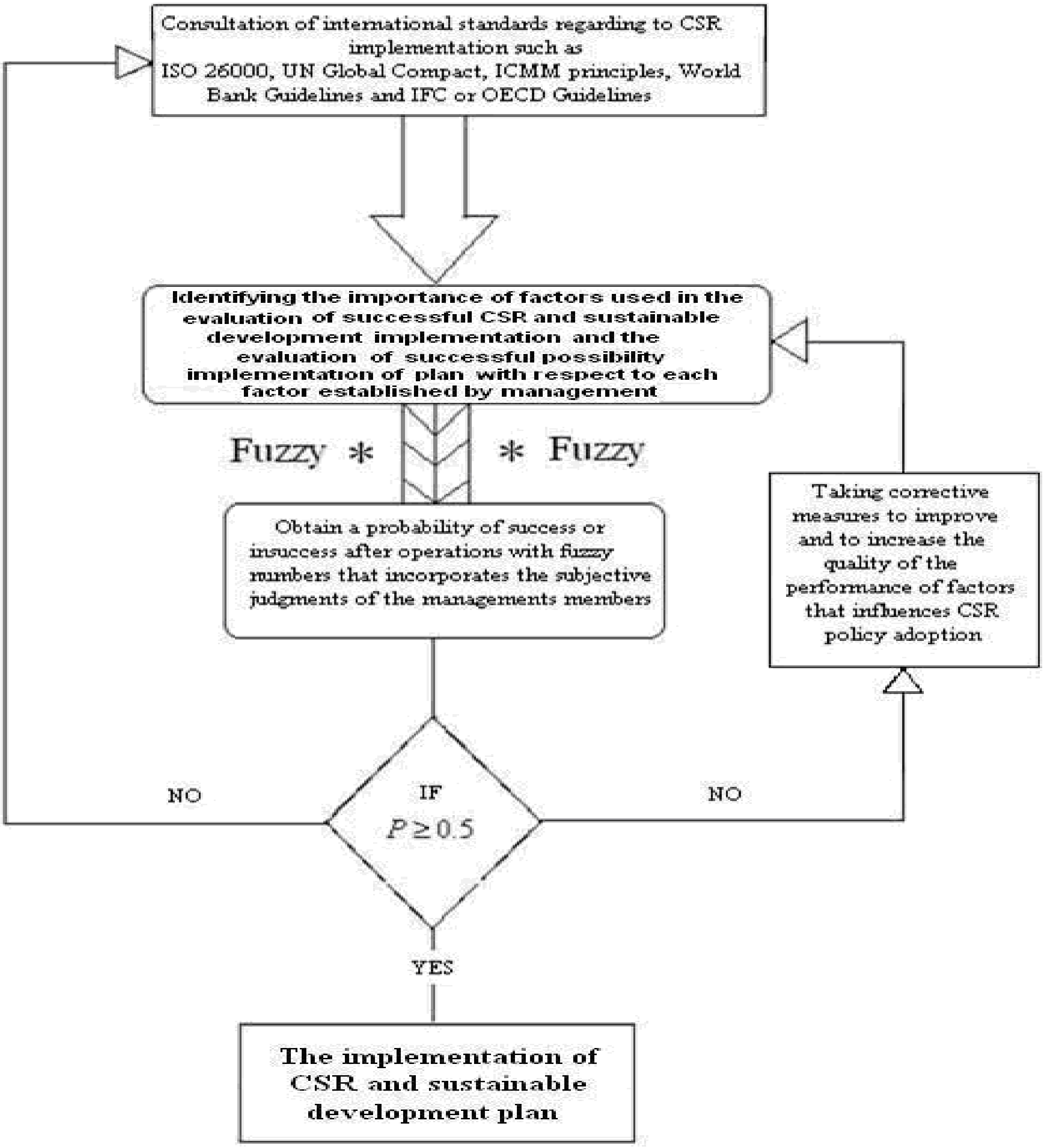

Fig. 4. The methodology design of prediction of successful or unsuccessful probability regarding to the CSR and sustainable development plan implementation using fuzzy logic

The propose methodology was designed after studying the prediction methodology using fuzzy sets conceived by [32], which thus have created a mathematical tool regarding the measurement of the successful implementation of knowledge management in a Taiwanese company, which finally resulted to be equal to 70%.

3.4 Assessing the Importance Weight of Factors That Conditioning the Implementation of CSR Policy

As I mentioned in the introduction, for having an effective and performing policy of corporate social responsibility, which should covering all community issues including those related to sustainable development, it is need for a bottom-up approach, a comprehensive one also, which primarily take out the community needs and its development, in parallel with company's business itself, so it cannot exist an effective and performing business if there it doesn't exist a well done sustainable plan for local community, based on key performance indicators (kpi).

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Table 3. The factors conditioning the implementation of CSR and sustainable development strategy

The main factor	The subfactor
F_1 **Corporate governance**	F_{11} Management independence from shareholders F_{12} Ethics in business and public commitments F_{13} Audit independence F_{14} Transparency F_{15} Litigations
F_2 **Economic impact**	F_{21} Promote procurement from local suppliers F_{22} Payment of taxes and fees F_{23} Hiring local people within the company structure F_{24} Compliance with the financial rights of employees F_{25} Village infrastructure development
F_3 **Health and safety employees**	F_{31} Reduction the number of accidents F_{32} Promotion of the constant use of personal protective equipment F_{33} Managing fatigue and improve general health and welfare of employees F_{34} Providing medical offices and specialized medical personnel F_{35} Training F_{36} Compliance with the law – fines and complaints
F_4 **Community involvement**	F_{41} Relations with community F_{42} Promoting community health and rights among its F_{43} The responsibility for resettlement and relocation F_{44} Social investments F_{45} Partnerships
F_5 **Supporting community traditions and cultural heritage conservation**	F_{51} Protect and preserve historic buildings and monuments F_{52} Monitoring and financing of archaeological work F_{53} Conservation and supporting the cultural traditions of community F_{54} Develop programs to attract tourists to the area
F_6 **Environmental impact**	F_{61} Objective for energy consumption and the greenhouse gas F_{62} Objective for consumption of fresh water F_{63} Objective to minimize waste F_{64} Objective for biodiversity protecting F_{65} Objective for the management of hazardous substances F_{66} Objective for the management of dumps and tailings ponds

For the performance weight evaluation of factors, it will be take into account their composition (their related sub factors), respectively of the importance weights of sub factors that shape the main factor. Until to reach to the final result, which is summarized

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in Table 4, it should be taken several steps summarized below:
1) Building of an importance matrix of factors denoted by I, which express the importance of each sub factor from the view of decision makers, in our case of the $k=4$ members of the management team from the superior level, whose opinion is expressed by linguistic values, converted then into triangular fuzzy numbers (see Tables 1 and 3). The matrix I looks like this:

$$I=\begin{bmatrix} i_{11}^{1} & \dots & \dots & i_{11}^{n} \\ i_{12}^{1} & \dots & \dots & i_{12}^{n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ i_{21}^{1} & \dots & \dots & i_{21}^{n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ i_{m1}^{1} & \dots & \dots & i_{m1}^{n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ i_{m\,r}^{1} & . & . & i_{m\,r}^{k} \end{bmatrix},\quad k=1,...,n \text{ deciders, } l=1,...,m \text{ factors, } p=1,...,r \textit{ subfactors of } F_m \quad (9)$$

where for example i_{21}^{2} represents the importance weight of sub factor F_{21}, which belongs to the main factor F_2, from the decider's view D_2.
2) Since each member's team management perception varies according to their hierarchical position, experience or knowledge, for having a conclusive picture of the importance of each sub factor, looked from the management team perspective and not from each separate member perspective, I will use the average method on these *n* evaluations made to each sub factor by these *n* assessors. Thus, for example, regarding the sub factor $F_{l\,1}$, which belongs to the main factor F_l, its importance will look like this:

$$IMP\ [F_{l\,1}]=\frac{i_{l\,1}^{1}+...+i_{l\,1}^{k}}{n},\ k=1,...,n,\ l=1,...,m. \quad (10)$$

3) Following these operations, it will result for each sub factor one fuzzy aggregate score, which will must be defuzzified into a crisp real number using [33]'s method, so as an example for a fuzzy number corresponding to the importance of sub factor $F_{l\,1}$, where for example $IMP\ [F_{l\,1}]=a=(a_1,a_2,a_3)$, the defuzzification formula will be:

$$D(IMP\ [F_{l\,1}])=\left(\frac{[(a_3-a_1)+(a_2-a_1)]}{3}+a_1\right)*\frac{1}{10},\quad l=1,...,m \quad (11)$$

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where $D(IMP\ [F_{l\,1}])$ represents the fixed real value of the sub factor's importance $F_{l\,1}$ resulted from the defuzzification operation.
4) After defuzzification of the triangular fuzzy numbers which represents the importance weight of each sub factor which in turn adjoining a main factor F_l, $l=1,...,m$, it will follow the normalization operation (denote by *N*). Thus, the importance of each sub factor will be transformed as follows:
- for example, if we take into discussion the factor F_l, $l=1,...,m$, which is composed of several sub factors, depending on the circumstances of their establishment, we have the following formula:

$$N(IMP[F_l]) = \frac{D(IMP\ [F_l])}{\sum_{l=1}^{m} D(IMP\ [F_l])} \qquad (12)$$

where $\sum_{l=1}^{m} N(IMP[F_l]) = 1$.
Analogous it is proceeding when we take into account instead of the main factors F_l, $l=1,...,m$, the many sub factors related to them (to the main factors), as can be seen in the practical example from the chapter 4, in Table 6, in the column whose header is *N*.

3.5 Assessing the Possibility of Successful CSR and Sustainable Development Implementation Strategy with Respect to Each Sub Factor

As I mentioned in subchapter 3.2, regarding the establishment of fuzzy numbers which includes the assessment of the possibility of successful implementation of CSR policy with respect to each factor initially set, these fall on a scale of values in the range $[0.0,1.0]$, reflecting thus the real expressed in percentage of these possibility. The steps which must be taken for assessing the possibility of success regarding to the implementation of CSR plan with respect to each sub factor, which are somewhat similar to those related to the evaluation of importance weights of sub factors from subchapter 3.4, will be detailed below and the results will be summarized in table 5:
1) The construction of a matrix for the evaluation of the possibility of successful implementation of CSR plan denoted by *S* and which expresses the opinion of every decision maker regarding to the successful possibility of plan implementation with respect to each sub factor, as follows:

$$S = \begin{bmatrix} s_{11}^1 & \dots & \dots & s_{11}^k \\ s_{12}^1 & \dots & \dots & s_{12}^k \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ s_{21}^1 & \dots & \dots & s_{21}^k \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ s_{m\,1}^1 & \dots & \dots & s_{m\,1}^k \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ s_{m\,r}^1 & . & . & s_{m\,r}^k \end{bmatrix}, \quad k=1,...,n \ \ deciders, \quad l=1,...,m \ \ factors, \quad p=1,...,r, \ \ subfactors\ of\ F_m \qquad (13)$$

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where for example s_{21}^2 represents the evaluation of the successful possibility of CSR plan with respect to sub factor F_{21}, taking into account the opinion of decision-maker D_2.

2) Since each member's team management perception varies according to their hierarchical position, experience or knowledge, to get a conclusive assessment on the possibility of successful implementation of CSR with respect to each sub factor, aspect looked at the management team level and not on separate member level, we will use the average method of the *n* evaluations made to each sub factor by each of the *n* evaluators, so as example for sub factor $F_{l\,1}$ the possibility of success will look like this:

$$SUCCESS\ \ [F_{l\,1}] = \frac{s_{l\,1}^1 + ... + s_{l\,1}^k}{n},\ k = 1,...,n,\ l = 1,...,m \qquad (14)$$

3) Following these operations, it will result for each sub factor in part a fuzzy aggregate score, which will must be defuzzified into a real crisp number using Opricovic and Tzeng's method (2004), so as example for a fuzzy number corresponding to the evaluation of the success possibility regarding to the CSR implementation plan with respect to sub factor $F_{l\,1}$, where $SUCCESS\ \ [F_{l\,1}] = b = (b_1, b_2, b_3)$, the defuzzification formula will be:

$$D(SUCCESS\ \ [F_{l\,1}]) = \left(\frac{[(b_3 - b_1) + (b_2 - b_1)]}{3} + b_1\right), \quad l = 1,...,m \qquad (15)$$

where $D(SUCCESS\ \ [F_{l\,1}])$ represents the fixed real value of the evaluation of the possibility related to the chances of successful implementation of CSR plan with respect to sub factor $F_{l\,1}$.

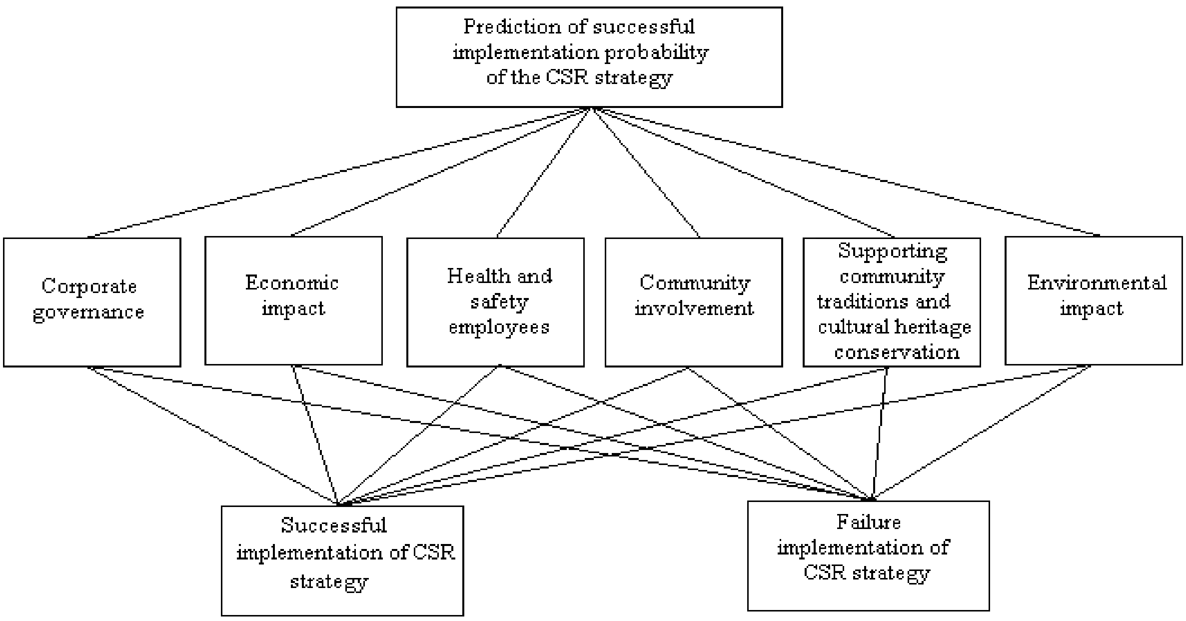

Fig. 5. Summary of the prediction process of the probability of success or failure implementation of CSR strategy

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3.6 Determining the Probability of Success in the CSR and Sustainable Development Strategy Implementation Case

For an overall view of this subchapter, we must necessarily regard the main factors contributing to the implementation of CSR and sustainable development strategy and the way of how this strategy succeeds to satisfy the performance requirements with respect to these factors, resulting so a possible success or a possible failure of implementation, as can be seen in Figure 5 and in Table 6 which contains the numerical results.

Following the operations discussed in previous chapters, where it has established the importance of each sub factor within their related main factors and also the evaluation of the possibility of success regarding to the CSR strategy implementation with respect to each of these sub factors, in the following we are left only to find which would be this probability, so:

$$P_{success} = \sum_{l=1}^{m} N(IMP[F_l]) * D(SUCCESS\ [F_l]), \quad l = 1,...,m \qquad (16)$$

where $N(IMP[F_l])$ represents the normalized weight of the importance of factor $F_l,\ \ l = 1,...,m$ and $D(SUCCESS\ [F_l])$ represents the evaluation of the possibility of success regarding to the CSR plan implementation with respect to each factor F_l.

Analogous it is proceeding when we take into account instead of the main factors $F_l,\ \ l = 1,...,m$, the many sub factors related to them (to the main factors), as can be seen in the practicable example from chapter 4, in table 6, in the column whose header is $P_{SUCCESS}$.

A more thorough and conclusive understanding can be seen from the next chapter, one that contains the actual implementation of this methodology within a practical case.

Following equation (16), it will result a probability of success in the range $[0,1]$. Of course, after determining the outcome, there it can be easily calculated either the probability of failure, as follows:

$$P_{failure} = 1 - P_{success}. \qquad (17)$$

In case that the probability of failure is higher or equal then the success ones, so $P_{failure} \geq 0.5$, it could be taken actions to improve and correct deficiencies regarding to the lines of action and their related performance in the implementation of CSR strategy.

4 Case Study to Predict the Possibility of Success in the Implementation of CSR and Sustainable Development Strategy by the Romanian Mining Company Roşia Montană Gold Corporation

Within the strategy of RMGC company, the implementation of CSR policy is an essential goal and represents a very important aspect regarding to the activity of a large company, especially of a one from the extractive industry, taking into account the great impact that it generates both economically and socially, but also environmentally. That's why, the prediction regarding to the probability of successful implementation of this policy of CSR represents a key aspect for the future directions of the company's actions in this area, because if we suppose that the forecast results are not the same we are expected to be, it could be take corrective measures to improve the practices and ways of CSR implementation.

According to the steps showed in chapter 3 above, we have the following results, summarized in Tables 4, 5 and 6.

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Table 4. The evaluation of the importance weight of sub factors

Subfactor	D_1	D_2	D_3	D_4	*IMP*	*D*(*IMP*)
F_{11}	fi- (5,8,9)	i - (2,5,8)	pi- (0,2,5)	i - (2,5,8)	(2.25,5,7.5)	**0.4916**
F_{12}	i - (2,5,8)	ei-(8,10,10)	i - (2,5,8)	fi- (5,8,9)	(4.25,7,8.75)	**0.6666**
F_{13}	fi- (5,8,9)	i - (2,5,8)	fi- (5,8,9)	i - (2,5,8)	(3.5,6.5,8.5)	**0.6166**
F_{14}	i - (2,5,8)	fi- (5,8,9)	pi- (0,2,5)	fi- (5,8,9)	(3,5.75,7.75)	**0.5500**
F_{15}	pi- (0,2,5)	fi- (5,8,9)	i - (2,5,8)	pi- (0,2,5)	(1.75,4.25,6.75)	**0.4250**
F_{21}	i - (2,5,8)	pi- (0,2,5)	ei-(8,10,10)	fpi-(0,0,2)	(2.5,4.25,6.25)	**0.4333**
F_{22}	fi- (5,8,9)	fi- (5,8,9)	ei-(8,10,10)	i - (2,5,8)	(5,7.75,9)	**0.7250**
F_{23}	i - (2,5,8)	i - (2,5,8)	fi- (5,8,9)	pi- (0,2,5)	(2.25,5,7.5)	**0.4916**
F_{24}	(8,10,10)	fi- (5,8,9)	ei-(8,10,10)	pi- (0,2,5)	(5.25,7.5,8.5)	**0.7083**
F_{25}	i - (2,5,8)	pi- (0,2,5)	ei-(8,10,10)	i - (2,5,8)	(3,5.5,7.75)	**0.5416**
F_{31}	fi- (5,8,9)	fi- (5,8,9)	i - (2,5,8)	i - (2,5,8)	(3.5,6.5,8.5)	**0.6166**
F_{32}	i - (2,5,8)	pi- (0,2,5)	fi- (5,8,9)	fi- (5,8,9)	(3,5.75,7.75)	**0.5500**
F_{33}	pi- (0,2,5)	i - (2,5,8)	fi- (5,8,9)	fpi-(0,0,2)	(1.75,3.75,6)	**0.3833**
F_{34}	i - (2,5,8)	pi- (0,2,5)	i - (2,5,8)	pi- (0,2,5)	(1,3.5,6.5)	**0.3666**
F_{35}	fi- (5,8,9)	i - (2,5,8)	i - (2,5,8)	pi- (0,2,5)	(2.25,5,7.5)	**0.4916**
F_{36}	i - (2,5,8)	ei-(8,10,10)	fi- (5,8,9)	i-(2,5,8)	(4.25,7,8.75)	**0.6666**
F_{41}	(8,10,10)	fi- (5,8,9)	(8,10,10)	i - (2,5,8)	(5.75,8.25,9.25)	**0.7750**
F_{42}	i - (2,5,8)	fi- (5,8,9)	fi- (5,8,9)	i - (2,5,8)	(3.5,6.5,8.5)	**0.6166**
F_{43}	fi- (5,8,9)	ei-(8,10,10)	ei-(8,10,10)	pi- (0,2,5)	(5.25,7.5,8.5)	**0.7083**
F_{44}	ei-(8,10,10)	fi- (5,8,9)	ei-(8,10,10)	i - (2,5,8)	(5.75,8.25,9.25)	**0.7750**
F_{45}	i - (2,5,8)	i - (2,5,8)	fi- (5,8,9)	i - (2,5,8)	(2.75,5.75,8.25)	**0.5583**
F_{51}	fi- (5,8,9)	i - (2,5,8)	ei-(8,10,10)	i - (2,5,8)	(4.25,7,8.75)	**0.6666**
F_{52}	i - (2,5,8)	pi- (0,2,5)	fi- (5,8,9)	pi- (0,2,5)	(1.75,4.25,6.75)	**0.4250**
F_{53}	fi- (5,8,9)	pi- (0,2,5)	fi- (5,8,9)	fpi-(0,0,2)	(2.5,4.5,6.25)	**0.4416**
F_{54}	i - (2,5,8)	i - (2,5,8)	fi- (5,8,9)	i - (2,5,8)	(2.75,5.75,8.25)	**0.5583**
F_{61}	fi- (5,8,9)	i - (2,5,8)	ei-(8,10,10)	ei-(8,10,10)	(5.75,8.25,9.25)	**0.7750**
F_{62}	i - (2,5,8)	i - (2,5,8)	fi- (5,8,9)	fi- (5,8,9)	(3.5,6.5,8.5)	**0.6166**
F_{63}	ei-(8,10,10)	fi- (5,8,9)	ei-(8,10,10)	ei-(8,10,10)	(7.25,9.5,9.75)	**0.8833**
F_{64}	fi- (5,8,9)	i - (2,5,8)	fi- (5,8,9)	ei-(8,10,10)	(5,7.75,9)	**0.7250**
F_{65}	fi- (5,8,9)	fi- (5,8,9)	fi- (5,8,9)	ei-(8,10,10)	(5.75,8.5,9.25)	**0.7833**
F_{66}	i - (2,5,8)	i - (2,5,8)	fi- (5,8,9)	fi- (5,8,9)	(3.5,6.5,8.5)	**0.6166**

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Table 5. The evaluation of the successful possibility of CSR and sustainable development strategy implementation with respect to each sub factor

Subfactor	D_1	D_2	D_3	D_4	$SUCCESS$	$D(SUCCESS)$
F_{11}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	pb- (0.0,0.1,0.4)	(0.15,0.4,0.7)	**0.4166**
F_{12}	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	(0.325,0.625,0.85)	**0.6000**
F_{13}	pb- (0.0,0.1,0.4)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	(0.075,0.325,0.625)	**0.3416**
F_{14}	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	pb- (0.0,0.1,0.4)	(0.225,0.475,0.775)	**0.4916**
F_{15}	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	(0.325,0.625,0.85)	**0.6000**
F_{21}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	(0.325,0.625,0.85)	**0.5750**
F_{22}	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	(0.4,0.7,0.85)	**0.6500**
F_{23}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	(0.325,0.625,0.85)	**0.6000**
F_{24}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	(0.325,0.625,0.925)	**0.6250**
F_{25}	ep- (0.7,1.0,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	(0.475,0.775,0.925)	**0.7250**
F_{31}	p- (0.1,0.4,0,7)	p- (0.1,0.4,0,7)	fp- (0.4,0.7,1.0)	pb- (0.0,0.1,0.4)	(0.15,0.4,0.7)	**0.4166**
F_{32}	pb- (0.0,0.1,0.4)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	fpb- (0.0,0.0,0.1)	(0.05,0.225,0.475)	**0.2500**
F_{33}	p- (0.1,0.4,0.7)	fpb- (0.0,0.0,0.1)	fp- (0.4,0.7,1.0)	fpb- (0.0,0.0,0.1)	(0.125,0.275,0.475)	**0.2916**
F_{34}	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	(0.175,0.475,0.775)	**0.4750**
F_{35}	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	(0.25,0.55,0.85)	**0.5500**
F_{36}	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	(0.325,0.625,0.85)	**0.6000**
F_{41}	p- (0.1,0.4,0.7)	pb- (0.0,0.1,0.4)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	(0.15,0.4,0.7)	**0.4166**
F_{42}	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	(0.175,0.475,0.775)	**0.4750**
F_{43}	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	p- (0.1,0.4,0.7)	(0.4,0.725,0.925)	**0.6833**
F_{44}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	fp- (0.4,0.7,1.0)	(0.4,0.7,0.925)	**0.6750**
F_{45}	pb- (0.0,0.1,0.4)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	pb- (0.0,0.1,0.4)	(0.125,0.325,0.625)	**0.3583**
F_{51}	p- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	fp- (0.4,0.7,1.0)	(0.475,0.775,1.0)	**0.7500**
F_{52}	p- (0.1,0.4,0,7)	ep- (0.7,1.0,1.0)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	(0.4,0.7,0.925)	**0.6750**
F_{53}	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	p- (0.1,0.4,0.7)	(0.1,0.4,0.7)	**0.4000**
F_{54}	fpb- (0.0,0.0,0.1)	pb- (0.0,0.1,0.4)	p- (0.1,0.4,0.7)	fpb- (0.0,0.0,0.1)	(0.025,0.125,0.325)	**0.1583**
F_{61}	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	(0.325,0.625,0.925)	**0.6250**
F_{62}	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	p- (0.1,0.4,0.7)	ep- (0.7,1.0,1.0)	(0.4,0.7,0.925)	**0.6750**
F_{63}	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	ep- (0.7,1.0,1.0)	(0.55,0.85,1.0)	**0.8000**
F_{64}	p- (0.1,0.4,0.7)	pb- (0.0,0.1,0.4)	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	(0.15,0.4,0.7)	**0.4166**
F_{65}	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	(0.475,0.775,1.0)	**0.7500**
F_{66}	p- (0.1,0.4,0.7)	fp- (0.4,0.7,1.0)	fp- (0.4,0.7,1.0)	ep- (0.7,1.0,1.0)	(0.4,0.7,0.925)	**0.6750**

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Table 6. The prediction of the successful probability of the CSR and sustainable development strategy implementation

The Subfactors	$D(IMP)$	$N(IMP)$	$D(SUCCESS)$	$P_{SUCCESS}$
F_{11}	0.4916	0.0264	0.4166	0.0110
F_{12}	0.6666	0.0357	0.6000	0.0214
F_{13}	0.6166	0.0331	0.3416	0.0113
F_{14}	0.5500	0.0295	0.4916	0.0145
F_{15}	0.4250	0.0228	0.6000	0.0137
F_{21}	0.4333	0.0232	0.5750	0.0133
F_{22}	0.7250	0.0389	0.6500	0.0253
F_{23}	0.4916	0.0264	0.6000	0.0158
F_{24}	0.7083	0.0380	0.6250	0.0238
F_{25}	0.5416	0.0290	0.7250	0.0210
F_{31}	0.6166	0.0331	0.4166	0.0138
F_{32}	0.5500	0.0295	0.2500	0.0074
F_{33}	0.3833	0.0206	0.2916	0.0060
F_{34}	0.3666	0.0197	0.4750	0.0094
F_{35}	0.4916	0.0264	0.5500	0.0145
F_{36}	0.6666	0.0357	0.6000	0.0214
F_{41}	0.7750	0.0416	0.4166	0.0173
F_{42}	0.6166	0.0331	0.4750	0.0157
F_{43}	0.7083	0.0380	0.6833	0.0260
F_{44}	0.7750	0.0416	0.6750	0.0281
F_{45}	0.5583	0.0300	0.3583	0.0110
F_{51}	0.6666	0.0357	0.7500	0.0268
F_{52}	0.4250	0.0228	0.6750	0.0154
F_{53}	0.4416	0.0237	0.4000	0.0095
F_{54}	0.5583	0.0300	0.1583	0.0047
F_{61}	0.7750	0.0416	0.6250	0.0260
F_{62}	0.6166	0.0331	0.6750	0.0223
F_{63}	0.8833	0.0474	0.8000	0.0379
F_{64}	0.7250	0.0389	0.4166	0.0162
F_{65}	0.7833	0.0420	0.7500	0.0315
F_{66}	0.6166	0.0331	0.6750	0.0223
The sum	18.6488	1.0000	-	0.5543

Thus, the prediction of the successful and failure probability of CSR and sustainable development strategy implementation will be determined finally according to formula (16) and respectively, to formula (17).

According to results from table 6, following the addition of the scored obtained on the column corresponding to the success probability that has the header $P_{SUCCESS}$, there it is resulting a success probability of CSR and sustainable development strategy implementation equal to 55,43 %, fact that it determines us to believe that mainly the objectives of this strategy are accomplished in conditions of effectiveness and performance. At the same time, it can be quantified either the failure probability of strategy implementation, according to formula (17), resulting so a failure probability equal to 44,57 %.

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5 Conclusions and Future Proposals

It is well known that within large companies and generally within multinationals it is current the fact of implementing a corporate social responsibility strategy for harmonize the expectations of all stakeholders in its area, responsibility which often materializes in satisfactory or less satisfactory results, according to the standard that it is implemented in relation to the international performance criteria and the tools available to the company concerned.

In addressing of the present paper, it was trying and it was getting the prediction of successful probability of CSR strategy implementation within a mining extraction company of mineral resources of gold and silver from Roşia Montană, in Romania.

There were two aspects into account, namely the importance weights of factors that influencing the CSR strategy implementation and the evaluation of the success possibility of this strategy implementation with respect to each factor. Using fuzzy logic in general and especially fuzzy multicriteria decision, it has been shaped the subjective opinions of decision-maker members, which in our case is composed of four top-level managers, opinions that were expressed by linguistic values and were then transformed into their related triangular fuzzy numbers according to figures 2 and 3, so that finally through fuzzification and defuzzification operations related to the formulas from this article to be determined the exact probability of 55,43 %, which represents the prediction of the successful probability of CSR and sustainable development strategy implementation, using fuzzy sets theory. Since it is an estimate amounting to over 50%, it results that this probability is encouraging regarding to the effective and performant implementation of CSR, but in the same time there is always place for better performances related to CSR objectives.

As proposals for the future, it could be realized certain informatics programs, either using a programming language, either databases or with other helpful tools, for manipulating in a reliable way of input and output data and for reducing the time allocation for calculation in the case that these are conducted, let's say, in a classical way. Also, this fact could reduce the risk of calculation errors, that in case of such a situation as is the one in this article, with many fuzzy numbers, fuzzification and defuzzification operations and others formulas, it is almost immediate and this fact also would reduce the risk of providing misleading results.

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Lucian SÎRB has graduated the Faculty of Informatics and the Faculty of Business Administration and in the present is PhD student at “Management of organizations” specialization, in the last year, within West University of Timişoara, Romania. He is currently working in the field of research related to his PhD thesis, which is about the application of fuzzy logic in the mining industry, especially within the management area of mining industry and particularly to the “Roşia Montană Mining Project” from Romania.

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