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Model of Raw Material Exploitation for the Support of Sustainable Development

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Abstract: The interactions between the indicators of sustainable regional development due to the exploitation of raw material deposits in the Slovak Republic are the starting point for effective raw material management. The primary objective of the study is to point out the interactions of explicitly defined indicators of raw material deposits exploitation, which have an overall impact on sustainable development in the Slovak Republic. Based on the development tendencies of selected social, economic, and environmental indicators, the article defines individual indicators that create the potential for further sustainable development. For an effective evaluation of all the indicators, the analytic hierarchy process was used for the identification of the priorities of the indicators. Based on all the relevant factors and previous experience, and results of the conducted analysis, 14 positive and 14 negative indicators were identified. Based on the complex evaluation of raw material in the process of sustainable development in the Slovak Republic, negative factors were prevailing over the positive ones by a scoring rate of 0.90, and the total impact was identified as average profitability of sustainable development support. Accepting all the principles of sustainable development, a model of effective evaluation of raw material deposits and management of raw material exploitation in regional sustainable development of the Slovak Republic based on the quantification of their interactions was developed.

Keywords: sustainable development; raw material; Saaty matrix; analytic hierarchy process (AHP)

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1. Introduction

The exploitation of raw material (RM) determines the sustainable development of the Slovak Republic (SR) in the primary, secondary, and tertiary spheres as it affects the environmental quality and social and economic development [1,2]. Mining of RM deposits decreases the environmental quality [3,4] and, at the same time, affects the social and economic area of sustainable development [5,6] as the exploitation determines the creation of jobs [7,8], the level of payments for mining space, and extracted minerals [9,10], state budget revenues from the payment of taxes on dependent activities, taxes on corporate income, and in the form of VAT [11]. All these factors form a comprehensive indicator of sustainable development whose synergy determines the actual exploitation of RM deposits in the context of sustainable development.

Sustainable development can be defined as "a development that preserves the opportunity to satisfy the basic living needs to the present and future generations while not diminishing the diversity of nature and preserving the natural functions of ecosystems" [12]. Globally, it is defined as "the development of civilization by meeting the needs of today's generation without sacrificing future generations" [13] and "maintaining the amount of the sources used by society for today's needs at a level that will not deprive future generations of their needs" [14]. Sustainable regional development with an implemented systematic use of exploitation of RM can be characterized as a strategic, complex, and synergic process determining the socioeconomic, environmental, and institutional aspects of regional development [15–17], profiling a functional model of anthropogenic society by eliminating the interventions that threaten, damage, or devastate the living conditions, adequate use of natural resources and protection of cultural and natural heritage [18,19]. Sustainable development in the mining industry affects society, the economy, and environment in both positive and negative ways. For this reason, sustainable development should be used simultaneously, not gradually [20,21]. RM extraction in remote and poor areas complies with sustainable development in job promotion, an increase in the income of inhabitants, and an enhancement in infrastructure [22]. However, RM extraction shapes not only the surface and underground, living, environment, economy, and society on the ground, and the future of the society, but also the inhabitants physically, emotionally, politically, and economically, the relation between inhabitants and their environment, the moving of inhabitants. This might also imply that mining and sustainable development are akin [23].

In order to build any infrastructure, make any instrument, obtain energy, produce food, etc., mining is necessary to obtain RM. RM extraction coincides with environmental disturbance, social impacts, and regional disparities based on the above discussion of international literature resources. For this reason, RM extraction should change, bring more equity, protect natural resources, and ecosystems in a more environmentally acceptable way and therein support sustainable development [6]. This is also why the paper deals with the interactions of RM exploitation determined by the adequacy, fairness, and sustainability of the fundamental pillars—social, economic, and environmental—in the context of the principles of sustainable development. Thus, the goal of the article is to develop a model for assessing the exploitation of RM deposits. It is for these reasons that the proposed model is based on the explicit identification of the indicators determining sustainable development.

The objective in the design of the evaluation of the exploitation of RM deposits is a clear identification of the category of the beneficial use of RM resources. It is conducted by real or predicted impacts on regional (or nationwide) development and, at the same time, the definition of the ultimately expected prosperity of a specific RM deposit, which is directly affected by the cost of mining and expected marketability in the context of promoting sustainable development. The topic of the article was selected due to the decline in RM exploitation in SR to support RM exploitation in a sustainable way. The analytic hierarchy process (AHP) was used for the prioritization of RM extraction indicators, and a model, applicable not only in SR but also in other regions of the world, was created.

2. Materials and Methods

Identification of indicators is based on the methodological procedure of the AHP using the so-called Saaty's matrix, which numerically identifies the priorities of the defined indicators in the field of promoting sustainable development. The data on the economic, environmental, and social aspects of the research problem was gathered and resolved into decision-making indicators. The quantification of synergistic interactions of the indicators distributed by numerical expression of their prioritization through their weights—α_i were realized. The numerical value of the weights α_i was set to all the indicators, accepting the generally valid condition of $\sum\alpha_i = 1$. The values of weights, in terms of the Saaty matrix principles with dimensions of $m \times n$, where $m = 1 \ldots i$ and $n = 1 \ldots j$, given by the number of rows and columns, respecting the condition $m = n$, were quantified. This symmetrical form of the matrix presents the strength of the indicators and also corresponds to the fact that the method is based on an interactive comparison of all defined indicators of the same order with the evaluation in Table 1 [18,24].

Table 1. Evaluation of negative and positive indicators.

Indicator Value	Description of Compared Indicators
1	Indicators *i* and *j* are equivalent
3	The indicator *i* is slightly preferred over the determinant *j*
5	The indicator *i* is strongly preferred over the determinant *j*
7	The indicator *i* is highly preferred over the determinant *j*
9	The indicator *i* is absolutely preferred over the determinant *j*

Then, the values of 1 were plotted on the diagonal of the matrix since the principle of comparing the same indicators, i.e., their equivalence, was accepted, and the pairwise comparisons of the individual indicators were identified. After evaluating individual indicators in this way, partial products of rows according to the relation were created:

$$S_i = \Pi S_{ij}, j = 1, 2, 3, \ldots, f, \tag{1}$$

with

f—number of factors,
S_{ij}—single factors.

Next, the R_i value for each criterion was quantified, i.e., a row of created matrix according to formula:

$$R_i = (S_i)^{1/f}, \tag{2}$$

Based on these calculations, the sum of R_i was counted, quantifying the final value of individual weights α_i reflecting the mutual interactions of comparative indicators of exploitation of RM deposits and their prioritization in the process of promoting sustainable development.

AHP was originally developed by Saaty and is a mathematical method for multi-criteria decision-making [25,26]. AHP was used for the selection of indicators for utilization of the RM base to create a model of effective management of RM base exploitation in processes of sustainable regional development due to its properties, including [24,27,28]:

- Flexibility, simplicity, and logical conciseness,
- Separation of a complex problem into smaller problems,
- Evaluation of problems by experts affecting the decision-making criteria.

AHP is a multi-criteria decision-making based on pairwise comparison. The comparison has a structure of hierarchy, including three levels—aim, criteria, and alternatives—the top, middle and bottom levels of the hierarchy, respectively [26–28]. There is no sophisticated mathematics in the AHP that allows focusing on each criterion. Therefore, it is a suitable multi-criteria decision-making method for RM exploitation in a sustainable way. The analysis was based on publications and manuals of Slovak and foreign authors, as presented in the Introduction, Materials and Methods, and Results sections, of the legislation, statistical databases, expert opinions, etc. The analysis was conducted for the period of 2002–2018.

This method was used in the assessment of sustainable development of hard coal mining industry in Poland with a result of a total of 24 evaluation criteria in economic, environmental, and social aspects [24]. It was also used in the assessment of sustainable development benefits in the Serbian mining companies with a result of 6 evaluation criteria for 5 alternatives of sustainable production and consumption, implementation of an integrated management system, introduction of clean technology, development of social responsibility, and environmental protection [29]. In a Vietnamese study, AHP was used to measure environmental problems from titan mining with 5 alternative sites on 8 criteria [30]. AHP was also used in the assessment of natural hazards and hazardous scenarios with recommendations in surface mines [31]. It can also be used for the evaluation of the socioeconomic structure of a province or municipality [32], rural development [33], coal mine sustainable development [34], regional level sustainability [35]. Other uses are for the evaluation of sustainable open pit mining and technical systems [36], sustainable product design in the context of green consumer behavior [37], stone crushing industries [38], critical success factors in disaster management [39], sustainable development, including human, economic, social, industrial, cultural, as well as health, safety, environmental, and energy factors [40], of selecting sustainable supplier countries for steel industry [41], sustainable production and consumption challenges [42], and sustainable production and consumption barriers and solutions [43]. It was also successfully used for the evaluation of lecturer research productivity [44], green supply chain management practices [45], the transformation efficiency of resource-based coastal cities [46], evaluation of the combined impact of coal mining on land use and the environment [47], sustainable exploitation of a coal deposit [48], the probability of a social conflict due to a mining project [49], cleaner mining [50], supply chain complexity drivers [51], ecology reclamation of mining subsided zones [52], sustainable development of mine water resources [53], brownfield and greenfield industrial parks investment projects [54], etc.

3. Results

The exploitation of RM deposits is characterized by positive impacts on the social and economic area of sustainable development in SR, as opposed to negative impacts on the environmental area of sustainable development in SR.

The exploitation of RM deposits contributes to the fulfillment of basic social and economic indicators of sustainable development since it also contributes to the development of employment, thus increasing household incomes and positively affecting the purchasing power and the standards of living. At the same time, it also generates revenues to the state budget and the municipal budget by not only paying for mining premises, extracted mineral or gas storage but also local taxes and fees, compulsory contributions from dependent activities, etc.

Employment in mining companies showed a decreasing tendency of development, which was logically related to the development of mineral resources mining and the use of technical and technological equipment for the mining of RM in SR. During the whole monitored period, employees working in opencast mining showed higher employment, which again was logically related to the prevailing surface method of exploitation of the RM in SR (Figure 1).

Given the above-mentioned tendency of employment in mining companies and the tendency of the average wage in SR, the state's income from employee and employer contributions by social security contributions amounted to 2.78 million. EUR per year, while the highest state revenues from social security contributions were in 2017, when they amounted to approximately 3.38 million. EUR and the lowest in 2007, when they accounted for about 2.56 million. This was logically related to the development of the average wage and number of employees (Figure 2). The revenues of the state budget, municipal budget, and environmental fund were also payments for mining space, extracted minerals, and gas storage. In the period under review (2002–2018), the highest incomes were generated in 2007, due to enormous growth of mining activity in the Bratislava mining area, when they reached approximately EUR 5.56 million, of which only 2.3% were payments for mining space (approx. EUR 126,550), 20.0% payments for gas storage (approx. EUR 1.12 million), to 77.8% (approx. EUR 32 million) payments for extracted minerals (Figure 3). During the mentioned period, the largest part of state budget revenues and municipal budgets were payments for extracted minerals, the amount of which was quantified on the basis of conditions regulated by the Government Regulation No. 50/2002 Coll. on the remuneration for the mining area, reimbursement for the extracted minerals, and reimbursement for the storage of gases or liquids, as amended. The remuneration for the mining area, which constituted the lowest incomes of the state and municipalities, was paid in the amount of 80% to the municipality in whose cadastral territory the mining area was situated and in the amount of 20% to the state budget.

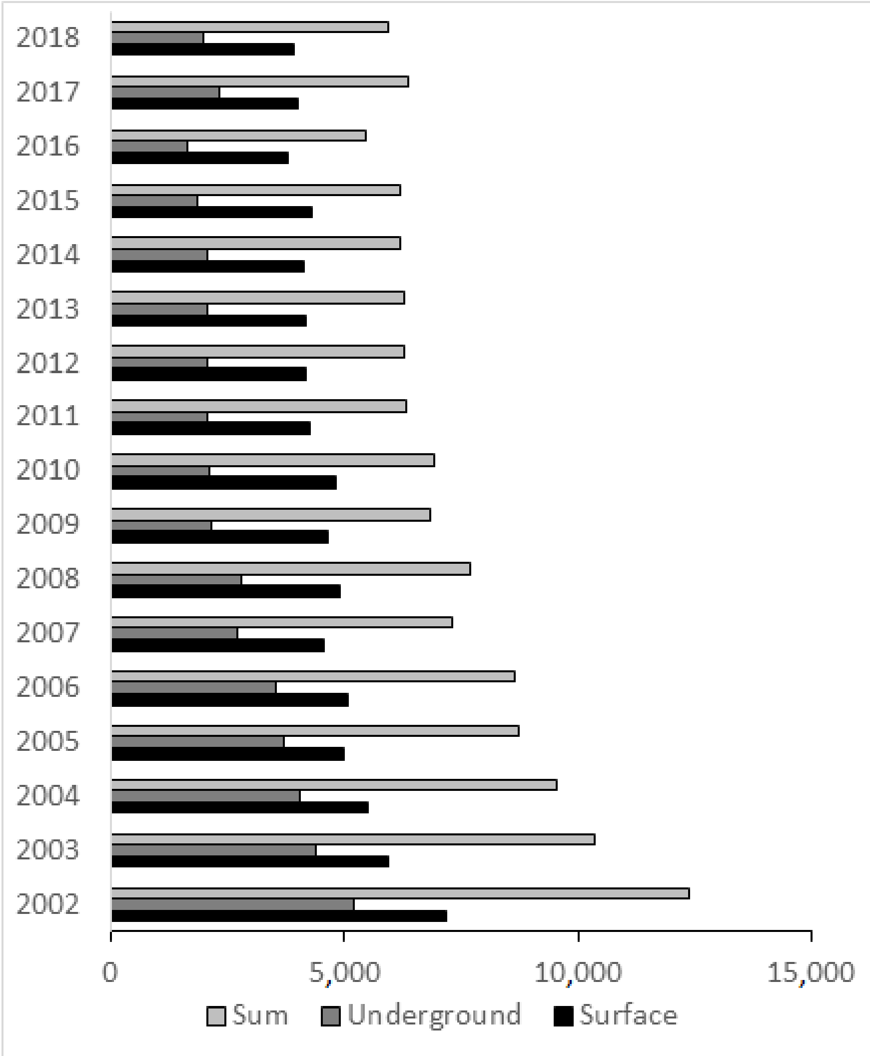

Figure 1. The tendency of employment in mining enterprises in SR (Slovak Republic) [55].

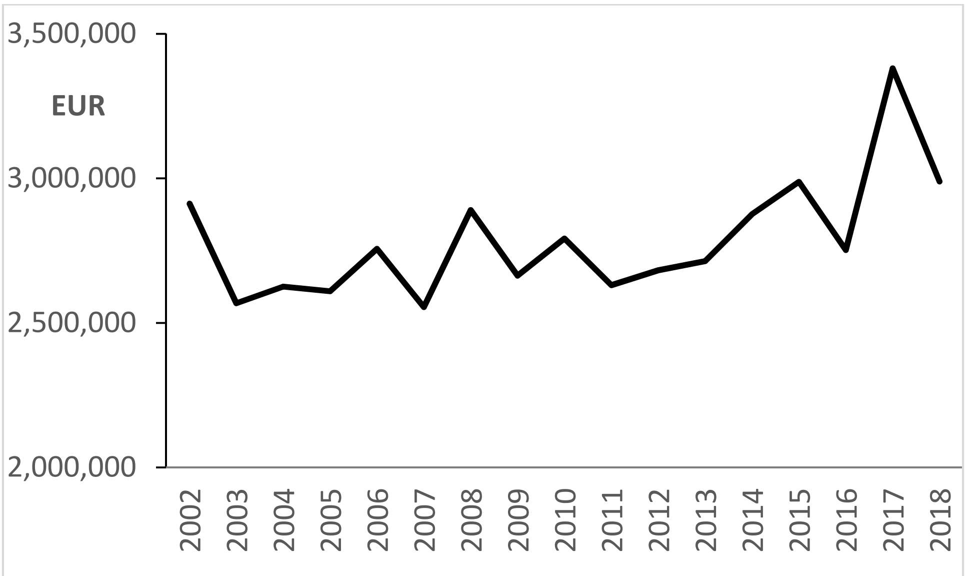

Figure 2. State revenue from social security contributions of employees [56].

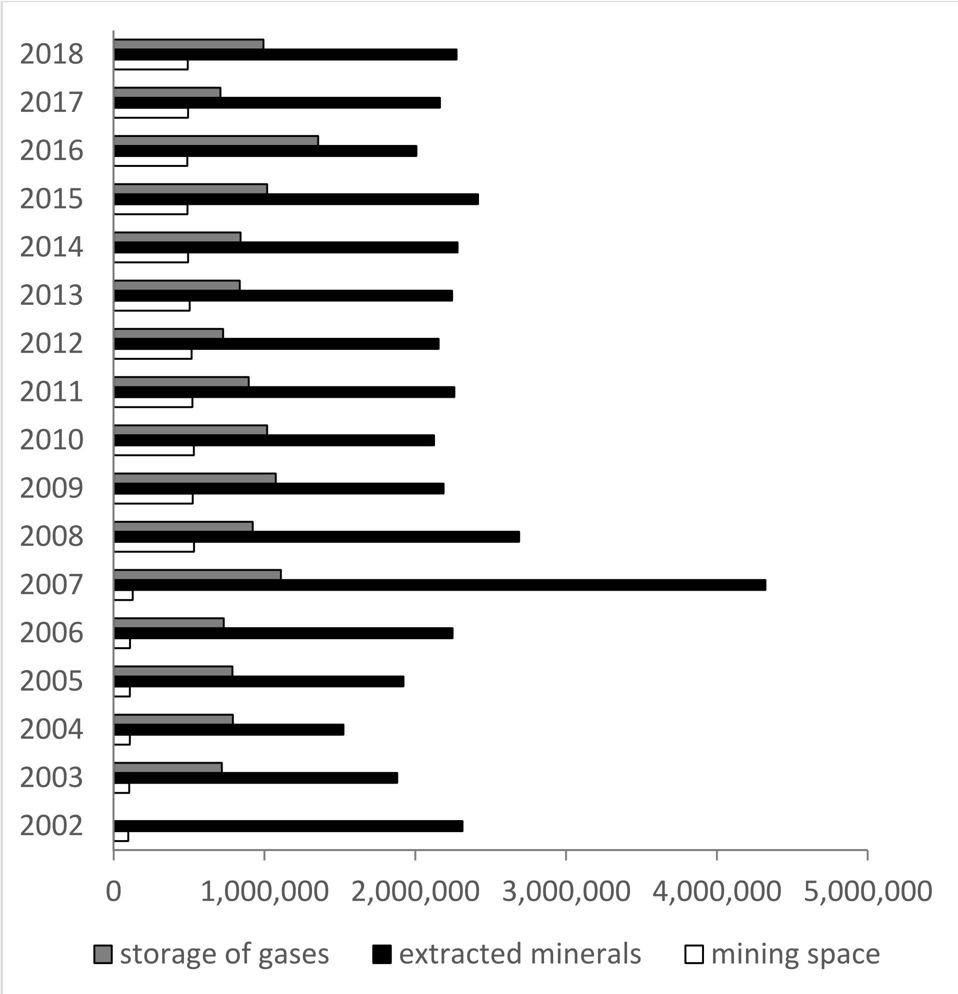

Figure 3. Payments from the exploitation of RM (raw material) base in SR [55].

Since the exploitation of RM deposits has a negative impact on the environmental quality, it is necessary to point out the current state of environmental burdens caused by the exploitation of the RM deposits. At present, on the basis of available data on environmental burdens following RM exploitation, under Act no. 569/2007 Coll. on Geological Works (Geological Act), defined as "pollution of an area caused by human activity that poses a serious risk to human health or rock environment, groundwater and soil with the exception of environmental damage", the most environmental burdens were currently registered in the region of Košice (27%) and the least in the region of Trenčín (1%) (Figure 4).

Based on the above facts, the comprehensive methodology of mineral exploitation evaluation was based on the quantification of synergistic interactions of environmental and socioeconomic indicators of RM exploitation, which were divided according to their impact into two groups of indicators affecting the sustainable development in conditions of SR. From previous experience and results of analyses, 14 positive and 14 negative indicators of RM utilization were identified, which was characterized by reversible and irreversible impacts on the environment in terms of support of sustainable development.

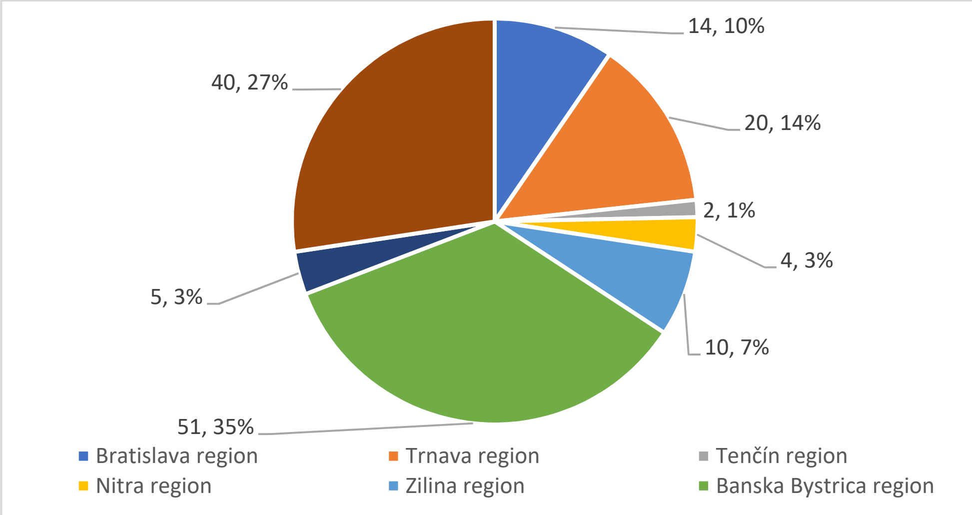

Figure 4. Environmental burdens after RM exploitation [57]. Note: number of environmental burdens; percent of total environmental burdens in SR.

In accord with higher mentioned methodological process weights—α_i were explicitly quantified for positive indicators (Table 2), including:

- I1—impact on the inhabitants' health.
- I2—impact on the natural environment (synergistic effect).
- I3—impact on the spheres of the Earth.
- I4—impact on the climatic conditions.
- I5—impact on the air.
- I6—impact on the hydrogeological conditions.
- I7—impact on the fauna.
- I8—impact on the flora.
- I9—impact on the protected areas in accord with valid legislative.
- I10—impact on the local system of ecological stability.
- I11—impact on the country and esthetical shape of natural environment.
- I12—impact on the municipality complex.
- I13—production of mining waste that is classified in accord with valid legislation as dangerous waste.
- I14—heaps, ponds, or old mining works that are, in accord with valid legislation, identified as environmental burdens.

Analogously, weights—α_i for negative indicators were quantified explicitly (Table 3), including:

- I1—increase of GDP per inhabitant.
- I2—support of social development.
- I3—employment increasing.
- I4—source of money for the state budget.
- I5—impact on the trade with RM.
- I6—increased autonomy for SR.
- I7—foreign direct investment (FDI) possibilities.
- I8—support of regional development.
- I9—positive financial effect for stakeholders.
- I10—increase of purchase power.
- I11—impact on the living standards of inhabitants.
- I12—amount of FDI inflowing.
- I13—increasing of work productivity index.
- I14—increasing of the average wage.

Table 2. Negative indicators of using RM (raw material).

[1] I	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	S_i	R_i	α_i
I1	1	3	5	3	3	3	3	3	3	5	5	3	3	7	17,222,625.0000	3.28749	0.19
I2	1/3	1	1	1/3	1	1/3	1/3	1	1	1/3	1	1	1/5	1/5	0.0002	0.53672	0.03
I3	1	1	1	1	3	1	3	3	3	1	5	1/5	3	5	1215.0000	1.66084	0.10
I4	1/3	3	1	1	1	1/3	1/3	1/3	1	1	1	1/5	1	1/3	0.0025	0.65126	0.04
I5	1/3	1	3	1	1	1/3	1	1	1/3	1/3	1	5	1/5	1/9	0.0041	0.67546	0.04
I6	1/3	3	1	3	3	1	3	3	1	1	1	1	1/3	1/3	9.0000	1.16993	0.07
I7	1/3	3	3	3	1	1/3	1	1	1	1	1/3	1/5	1/7	1/9	0.0032	0.66305	0.04
I8	1/3	1	3	3	1	1/3	1	1	1	1	1	1/5	1/7	1/7	0.0041	0.67506	0.04
I9	1/3	1	1	1	3	3	1	1	1	1	1	1/3	5	1/3	1.6667	1.03716	0.06
I10	1/5	3	1	1	3	3	1	1	1	1	3	5	3	1/3	81.0000	1.36874	0.08
I11	1/5	1	1	1	1	1	3	1	1	1/3	1	3	5	1/3	0.0400	0.79460	0.05
I12	1/3	1	5	5	1/5	1/5	5	5	5	1/5	1/3	1	1/3	1/5	0.1852	0.88652	0.05
I13	1/3	5	1/3	1	5	5	7	7	1/5	1/3	5	3	1	1	680.5556	1.59348	0.09
I14	1/7	5	1/5	3	9	9	9	7	3	3	3	5	1	1	292,245.0000	2.45882	0.14
[2] S																17.4591	1.00

[1] I = indicator/interaction. [2] S = Sum.

Table 3. Positive indicators of using RM.

[1] I	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	S_i	R_i	α_i
I1	1	1	1/3	5	1/3	1/3	1	1/5	1/5	1	1/5	1/7	1/3	3	0.0002	0.5464	0.03
I2	1	1	1/5	1/3	1/3	1/5	1/3	1	1	1/3	1	1/7	1/3	5	0.0001	0.5240	0.03
I3	3	5	1	1/3	1/5	1/3	1/3	7	5	3	5	1/3	1/3	1	6.4815	1.1428	0.07
I4	1/5	3	3	1	1/3	1/3	1/3	1/5	1	1/5	1/7	1/3	1/3	1/7	0.0000	0.4239	0.03
I5	3	3	5	3	1	1	1/3	1/5	1	1/3	1/3	1	1/3	1/5	0.0667	0.8241	0.05
I6	3	5	3	3	1	1	3	1/3	1/3	1/3	1/5	1	1	1/7	0.4286	0.9413	0.06
I7	1	3	3	3	3	1/3	1	1/3	1	1/5	1/5	1	1	1/3	0.1200	0.8595	0.05
I8	5	1	1/7	5	5	3	3	1	5	3	1	1	1	1/3	803.5714	1.6125	0.10
I9	5	1	1/5	1	1	3	1	1/5	1	1/3	1/5	1	1	1/3	0.0133	0.7346	0.05
I10	1	3	1/3	5	3	3	5	1/3	3	1	1	3	1	1	675.0000	1.5926	0.10
I11	1/5	1	1	7	3	5	5	1	5	1	1	3	3	1	4725.0000	1.8300	0.12
I12	7	7	3	3	1	1	1	1	1	1/3	1/3	1	1	1/5	9.8000	1.1771	0.07
I13	3	3	3	3	3	1	1	1	1	3	3	3	1	5	32,805.0000	2.1017	0.13
I14	1	1	1	1/3	5	7	3	3	3	1	1	5	1/5	1	315.0000	1.5082	0.10
[2] S																15.8186	1.00

[1] I = indicator/interaction. [2] S = Sum.

Constructing the summary matrix of complex evaluation of RM using in the processes of sustainable development, negative indicators (52.70%) prevailed over positive ones (47.30%) with a value of the summary scoring rate of 0.90 (Table 4), which predicted the category of regional development supports. In this way, also the total impact of RM exploitation in a particular region was identified as III. category, which means average profitability of sustainable development support since the scoring rate achieved the mentioned value of 0.90 (Table 5).

Table 4. Effect of RM exploitation on the regional development of SR (Slovak Republic).

Indicator/Interaction	Determinants	Partial Score	Score	Scoring Rate
impact on the inhabitants' health	−	9.83	52.70	0.90
impact on the natural environment (syner. ef.)	−	1.60		
impact on the spheres of the Earth	−	4.97		
impact on the climatic conditions	−	1.95		
impact on the air	−	2.02		
impact on the hydrogeological conditions	−	3.50		
impact on the fauna	−	1.98		
impact on the flora	−	2.02		
impact on the protected areas	−	3.10		
impact on the ecological stability	−	4.09		
impact on the country	−	2.38		
impact on the municipality complex	−	2.65		
production of mining waste	−	5.26		
heaps, ponds, or old mining works	−	7.35		
increase of GDP per inhabitant	+	1.63	47.30	
support of social development	+	1.57		
employment increasing	+	3.42		
source of money for state budget	+	1.27		
impact on the trade with RM	+	2.46		
increased autonomy for SR	+	2.81		
FDI possibilities	+	2.57		
support of regional development	+	4.82		
positive financial effect for stakeholders	+	2.20		
increase of purchase power	+	4.76		
impact on the living standards	+	5.47		
amount of FDI inflowing	+	3.52		
increasing of work productivity index	+	6.28		
increasing of average wage	+	4.51		

Table 5. Categorization of RM using effects on sustainable development in SR.

Category of RM Mining Utility		Level of Profitability
I. category	Very high	over 1.80
II. category	High	1.79–1.30
III. category	Average	1.99–0.80
IV. category	Low	0.79–0.30
V. category	Very low	0.29 and less

4. Discussion

Effective system of management of sustainable regional development in SR is an integral part of exploitation of the RM base in SR. It should respect all specifications of the regions, as well as the RM deposits and the way of RM extraction, including inputs from the side of a potential investor. At this system of management of sustainable regional development, it would be necessary to also include total costs, connected with realization of RM extraction project, total economic contributions, supporting the development of regional economy in interaction with the development of social pillar of sustainable development of regions with accent given to moderation of development of interregional disparities. From the results of the quantitative analysis and comparison of selected indexes for support of social and economic development of regions, basic aspects, determining sustainable development, payment for mining space and extracted raw material, state incomes by way of deductions and payroll taxes, income tax, value-added tax were added. Since regional development in accord with principles of sustainable development had been followed in two interactive levels. Economic indexes, determining the economic position of a single investor, also called a potential FDI bearer, and the volume of necessary investment costs, total costs, and total incomes, connected with chronologic duration of exploitation of RM base, and net profit were added among secondary indexes.

The system of management of RM base exploitation in SR in processes of regional development, defined in such a way, could be characterized clearly by determining rules of monitoring and regular evaluation of predetermined indexes of development, by acceptation of rules and principles of sustainable development at the level of regions and obviously by observing of legislation, connected with single extraction of RM deposits.

Model of effective management of RM base exploitation in processes of sustainable regional development had been suggested by the way to respect all external and internal factors, effecting individual sub-processes of regional development, resulting from extraction and consequent using of RM base, determining final utility, resulting from comparative synthesis of matrix results from the evaluation of negative and positive indicators with integrated scoring rate by the way that illustrates the model of management of RM exploitation in regional development (Figure 5).

RM exploitation should be associated with sustainable development at a global scale and ensure the satisfaction of basic needs by ensuring available RM for the present and future generations [6]. The national sustainable development of mining in the context of its challenges, at the stage of planning of making subsequent deposits available, in the modern design of mining activities, presents the possibilities of social development in a local context. A new mine that generates many jobs must follow new trends to be socially and environmentally responsible. The environmental and social guidelines are part of the global guidelines addressed to the mining industry. A reliable assessment of cumulated, time and spatial social and environmental impacts can prove the interdisciplinary nature of determining the impact of mining activities. Local communities may benefit from a functioning mining plant in a region with disparities by taking care of the environment by initiatives or projects supporting renewable energy sources in the context of regional economic development, a decrease in poverty, and an improvement of the living quality. It has been proven that social aspects are important within the scope of free, conscious, bilateral acceptance of environmental activities [7].

RM exploitation, due to growing public attention of the problem and impacts associated with exploitation and processing of RM, engages environmental aspects as RM extraction is joined with environmental impacts and risks for the local and even regional environments [4]. Economic, social, and environmental aspects of sustainable development in mining are interrelated as the environmental approach afflicts the economy and the quality of life. Yet, the inclusion of sustainable development assumes that the availability of RM is extended for a longer period and modernized technologies are introduced in RM exploitation to minimize the use of RM with concurrent maximization of profit [20]. All resources in achieving sustainable development must be developed in the cultural capital that is the resource in managing the natural, human, social, physical, and financial capitals thus it is more effective as it considers cultural context and diversity, thus sustainable development gets a new altitude, changes that are more sustainable [13]. In a previous Slovak study, it was also confirmed that the economic value of a deposit and of extraction in the form of income was not the only contribution for the region and the state but there was an added value in the form of raised social level and improved quality of life for the inhabitants. Created jobs improve the purchasing power of the region and increase trade and services [2].

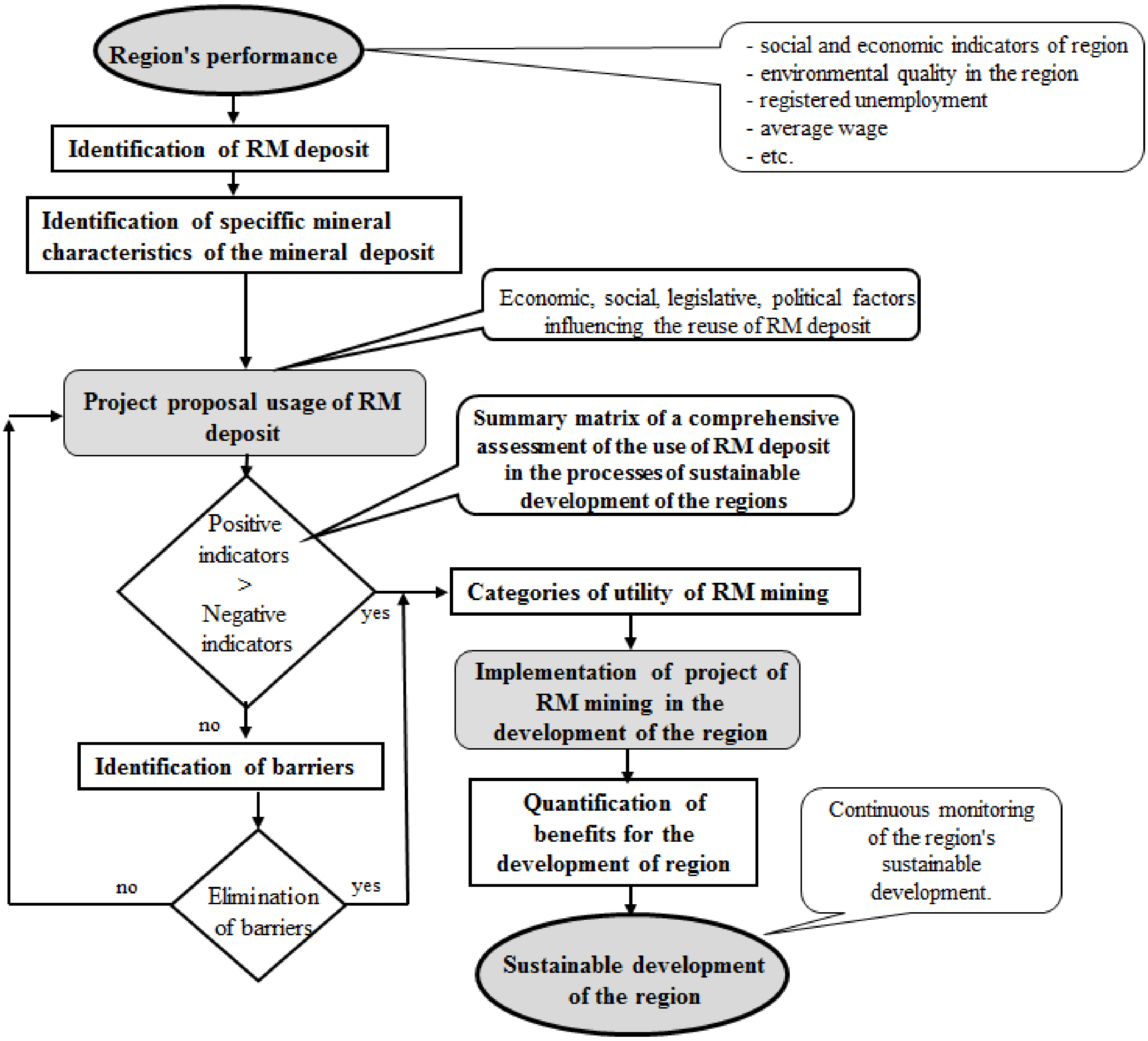

Figure 5. Model of effective management of RM exploitation in processes of sustainable regional development.

A case study in Western Australia suggested that RM extraction can draw global capital and development that might not occur otherwise to regions with disparities but most of the profit is accumulated in the region without disparities. This fact is given by the concentration of global companies operating their financial and investment decision-making, engineering, construction, and research in more developed regions [10]. Even in developing countries of Africa, prioritization of development intervention can have an impact on project outcomes at a regional level. Project sustainability and value-for-money can be ensured by the implementation of various techniques [33]. For a mining company, the long-term profitability may be negatively affected by tax, which may lead to a reduction in investments. The mining fee is a public imposition with fiscal and non-fiscal functions implementing operating costs and environmental damage and consequently compensations caused by the exploitation of raw material [11].

Sustainable development goals in the context of the Polish mining industry vary by different mining companies. By an assessment of the strengths and weaknesses of the industry awareness towards sustainable development in environmental, social, and economic domains, the image of companies has significantly improved, but there are still limitations and difficulties in implementing changes due to legal regulations that require finalization [16]. In India, long-term regional sustainability issues, based on stakeholders' prioritization, were also identified as social, economic, and environmental [35]. Even certain changes in technology may have a negative impact on social and economic aspects as well as the environment [36]. In addition, in sustainable waste management, which may become a secondary RM, economic, environmental, and social criteria are an integral part of both the assessment and the diagnosis of the reasons for changes. Applying specific macroeconomic indicators and reflecting the state of legislative and executive initiatives enables the development of an integrated indicator, which includes social, economic, and environmental factors [15].

In Serbia, based on an assessment of sustainable development benefits in mining companies, it was found that the most important criterion was competitiveness, application of international standards of the efficiency, sustainable use of the natural resources, and product quality, followed by quality control of the process, reduction of costs, the introduction of new technologies, simpler procedures, and information of the employees and their participation in the decision-making process [29]. In Vietnam, RM (titan) mining most seriously affects the forests as not many forests are left along the coast. Therefore, in this area, RM mining emulates beach tourism, agricultural production, and housing that demand space [30]. The factors for sustainable exploitation of RM resources and energy are ecological protection, ecological management, pollution control, and resource comprehensive utilization for black coal in China [34], management, environmental protection, mining technique, mining economic indicators, comprehensive utilization level of waste, and processed environmental level for phosphorus in China [50], and RM thickness, stripping ratio, lower calorific value, and hard formations thickness for lignin in Greece [48].

Suggested model of management of RM exploitation in regional development with the goal to decrease interregional disparities and to increase the competitiveness of Slovakian regions with the tendency of increasing polarization in the region of Bratislava, had been constructed by the way that it could integrate following areas of analyzed problem solving, based on the studied cases in SR and worldwide:

- Present state of deposit of RM in accordance with applied legislation connected sustainable exploitation of RM in SR.
- Identification of regional development tendencies according chosen relevant indicators.
- Comparison of utility of concrete deposit of RM and its social and economic contributions for the region development.
- Suggestion of the deposit exploitation project according to the needs and specifications of a particular region.
- Identification and evaluation of benefits and barriers, preliminary category of the region support according scoring rate.
- After monitoring of indexes of the regional development by using development activities orientated to the potential of particular RM base exploitation, allocated at the region.

5. Conclusions

The worldwide importance of RM is obvious from the interpretation of their effect on the world economy, state economy, and regional economy. RM safety is mainly about availability, and RM is more important in the present time than in the past. In addition, the European Union put RM safety among priorities [58–60]. This cannot be limited or disadvantaged by aspects of non-effective or improper decisions of member states, especially states that do not have a direct impact on their RM base and that deform RM base by tendentious opinions to the RM base and use. It is for these reasons that the article deals with the quantification of the interaction links of the exploitation of raw material deposits, which determines the potential categorization of the impacts of the use of RM on sustainable development. Based on a detailed analysis, a quantification of synergistic interactions of environmental and socioeconomic indicators of RM exploitation was provided. These interactions were grouped according to their impact affecting the sustainable development in conditions of SR, based on the previous experience and results, into 14 positive and 14 negative indicators of RM utilization identified by reversible and irreversible impacts on the environment in terms of support of sustainable development. Having constructed the summary matrix of complex evaluation of RM in sustainable development, negative indicators (52.70%) prevailed over positive ones (47.30%). The value of the summary scoring rate was 0.90, assuming the category of regional development supports thus the total impact of RM exploitation was identified as III. category, presuming average profitability of sustainable development support.

But the presented analysis also has some limitations. The AHP was based on decision-making with 14 positive and 14 negative factors that were identified on the RM deposits exploitation for the support of regional development and the quantification of weights according to the methodological procedure with the determination of their priority in the decision-making process. The factors were selected depending on publications and manuals of Slovak and foreign authors, regulations of the legislation, Slovak statistical databases, expert opinions, etc. Future studies may reconsider the use of other methods for evaluation as well as include other positive/negative factors and other (re)sources. The results were considered for the local situation in SR. However, they may be generalized for other regions, and the proposed model of effective management of RM exploitation in processes of sustainable regional development may be used anywhere in the world.

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